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TRAFFIC QUARTERLY

AN INDEPENDENT JOURNAL FOR BETTER TRAFFIC

JANUARY 1959

Poor Drivers
City Street Capacity
A California Freeway System
Improved Traffic, Urban Renewal
Pittsburgh's Transportation Program
Financing Metropolitan Transportation
Tourists and Traffic: Hawaii, Miami Beach
Monitoring Traffic Speeds and Volume
Ribbon Development in Australia
Traffic and Rebuilding Cities
Expressway Planning in Tulsa
Lansing's One-Way Streets
Freeway Access Controls
Parking Comes of Age

THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL

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Poor Drivers

On each occasion, the reporting of highway accidents on week-ends and holidays varies only within narrow limits. It should shock the public to demand remedial action—procedural action. This requires, on the part of all states, *unanimity* of action, sufficiently vigorous to arouse a well-disposed public.

The motive of widespread publicity about holiday accidents is well-intentioned but too casually accepted. Each report should be followed on the earliest occasion by determined, if necessary, *severe*, measures to prove to the public that patient endurance is approaching an end.

Many sensible drivers, impressed by these high accident rates and the ominous threat to their safety, shy at week-end and holiday travel. Many business firms financially concerned have perforce resorted to cautious measures.

Some insurance companies go to great lengths to *classify* drivers. These classifications are varied, but in general are based on driver type and age, number of drivers, car-use by type and distance. Cars driven by young drivers require increased insurance premiums. A few states require compulsory insurance. In most of these limitations or precautions, skill or competence is least considered. These insurance procedures, inescapable, stem from necessity and efficient business practice. They are primarily protective, not necessarily constructive, but such actions are imperative to assure financial security to the companies and fairness to policy subscribers.

No widespread effective procedure has been adopted that impressively warns the licensee of the seriousness of any improper use of his license.

The extent of faulty and discourteous driving is commonly known. It is regarded with great leniency and unwarranted toleration. We have good roads, good cars, but too many poor drivers.

The full burden of licensing and of reasonable control of traffic is unequivocally the responsibility of cities and states. This serious obligation is fully appreciated by the responsive element of the driving public, who would welcome the adoption of extreme meas-

ures, if effective, pointed and purposely directed at careless, unqualified and irresponsive drivers.

Some attempts at initiating this type of remedial measure have made little progress, not because of lack of recognition of the exigency of the situation, but because of apprehension of unfavorable public reaction.

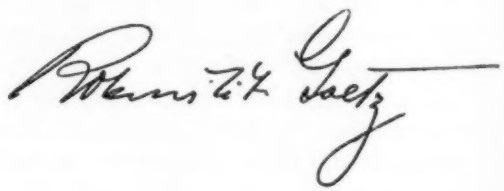
Some drivers, though officially holding an authorized permit, obviously demonstrate inherent inability to drive a motor vehicle properly.

Some of our corrective legal procedures are at variance and difficult to enforce. Others are ineffective in cases where small fines have little bearing on the security of the driver's permit.

A driver values his permit highly but uses it carelessly.

Well-intentioned, but ineffective measures, along with the diversity of enforcement, add to driver negligence and arouse public concern.

We need something more than signs and slogans. We need to *foster a driver's creed.*



Traffic Improvement, Urban Renewal

RICHARD L. STEINER

Mr. Steiner is Commissioner of the Urban Renewal Administration, Housing and Home Finance Agency, Washington, D.C. He is a graduate of Yale University in civil engineering and also attended Massachusetts Institute of Technology, receiving the degree of Master in City Planning. He was appointed Deputy Director of the Division of Slum Clearance and Urban Redevelopment, Housing and Home Finance Agency in 1954. When the Division was converted to the Urban Renewal Administration, he became Deputy Commissioner of the new unit. He was Acting Commissioner from September 10, 1956, when Commissioner James W. Follin resigned, until his appointment as Commissioner on April 1, 1957. Previously, Mr. Steiner was Director of the Baltimore, Maryland, Redevelopment Commission from 1946 to 1954, responsible for developing and carrying out the program of slum clearance and urban redevelopment.

URBAN renewal, as carried out by communities across the nation, modernizes worn-out areas of cities. Through this process the individual community eliminates slums and prevents the formation of future ones.

Urban renewal has to do mainly with three broad local fields of endeavor—the clearance and rebuilding of areas beyond redemption, the improvement of neighborhoods on the downgrade, yet basically sound, and the conservation of good areas.

Of necessity, urban renewal is a local program, locally evolved, locally carried out. It need not be federally assisted, though federal aid has been available to communities for about ten years. Whether federally assisted or not, urban renewal—if it is to be successful—calls for top-notch planning, concerted effort, and full co-ordination of local forces.

In the broad scope of urban renewal, decent housing for Americans has been, and remains, a primary objective. Yet improved housing today is but one part of the sweeping action toward total civic improvement, a vital segment of a comprehensive program that reaches across the whole community to achieve city rebuilding in the fullest sense.

Urban renewal, among other things, has given American cities their first chance to reform themselves in response to the realities of the automobile age.

The massive federally aided highway program, in a great many communities, is going forward simultaneously with the urban renewal program. The two can contribute to civic improvement.

There is, of course, the potential for conflict and confusion between these two great programs. But that need not be the case and indeed in many cities is not the case. Traffic improvement and urban renewal can sustain and support each other if both are guided and co-ordinated through sound city and metropolitan planning.

'Making Better' Sometimes Retards

Traffic engineers have probably contributed in large measure to retarding rather than to accelerating civic improvement since their role has frequently been to find ways to make an obsolete city pattern serve a little longer. Much of their effort has been patchwork and repair rather than new creation. This is not a criticism. The traffic engineer has only been performing a function that practical economics has made completely necessary. And certain types of urban renewal will continue to place demands upon the traffic engineer to find solutions to traffic problems without drastic reconstruction of street patterns.

We are at the point, however, where in many situations the ingenuity of the traffic engineer can no longer preserve outmoded street systems. A vigorous movement of redesigning and rebuilding American cities to meet the demands of modern urban life and economy is under way.

Urban renewal—outside of its important aspect of preventing and eliminating slums—is not an end in itself but a tool for accomplishing a community's requirements for improving its physical structure. These requirements are expressed in a community's general plan. Under the law, the plan for an urban renewal area must conform to the general plan. The record of general planning admittedly is not perfect. In some instances, general plan determinations have been made almost concurrently with urban renewal planning decisions.

One of the objectives of a community's general plan is, of course, the improvement of highways, streets, parking facilities, and general traffic conditions. Highway and traffic and urban renewal activities are interrelated in serving general planning objectives. Perhaps the most spectacular evidence is the large number of urban renewal projects that provide or include major expressways, significant off-street parking facilities, street widening and realignment and other adjustments.

Urban Renewals Aid Highway Development

Norfolk, Virginia, is a good example of cities that have used urban renewal to assist in the development of needed highways. Two contiguous urban renewal projects provide rights-of-way for part of a proposed major expressway along the waterfront and for a significant segment of a planned arterial street on the circumference of the central business district. Twenty-seven of the 115 acres in Norfolk's Atlantic City project will be used for the right-of-way (up to 140 feet in width) for a divided highway that will connect Hampton Boulevard with Brambleton Avenue and the central business district.

This single traffic facility, long needed and planned for in Norfolk, will replace the several "tortuous, discontinuous, and narrow" routes previously connecting Hampton Avenue and the business district. Thus urban renewal will not only serve to eliminate a badly deteriorating area but also will eliminate one of the city's traffic headaches.

The 225-acre Wooster Square project in New Haven, Connecticut, is situated at an intersection of two planned major expressways and is bisected by one of them. This project illustrates not only how an urban renewal area often includes major highways but also how a project can take advantage of these highways by using them as valuable transportation facilities for proposed industrial sites and as buffer separations between industrial and residential developments. Almost one-third of the area of another New Haven urban renewal undertaking, the Oak Street project, will be used for the proposed Oak Street connector, a wide expressway providing traffic relief for downtown.

A shopping garage estimated to cost more than $5.5 million will be built in the Church Street project in New Haven. This garage and an additional parking area proposed within the project will serve the project's retail shopping center in addition to some of downtown New Haven. In New York City, off-street parking facilities estimated to cost about $4 million will be constructed as part of the development of the Lincoln Square project.

Renewal Plans Widen Existing Routes

A great many major street and highway plans have been advanced within urban renewal projects, not with completely new rights-of-way, but by widening existing traffic routes. The urban renewal plan for the East Dayton project in Dayton, Ohio, proposes to widen portions of Fifth Street and Wayne Avenue, important elements in the city's major highway system. Fifth Street, for example, will be widened so as to provide four traffic lanes, a median strip with left turn lanes and sidewalks.

Fort Street in Port Huron, Michigan, will be widened in accordance with the renewal plan to a four-lane divided street in anticipation of its becoming a major route through the city. The Church Street project in New Haven will accomplish the widening of Church Street, an ancient traffic problem, and its extension to the railroad station. An adequate route from the station to "The Green" and the Yale University area has long been an objective in New Haven's general planning.

Urban renewal in Norfolk also illustrates sound highway and traffic planning principles with respect to the provision of parking to serve a central business district type of development easily accessible from a major service route. Duquesne, Pennsylvania, has a project which will extend the commercial area of its central business district and at the same time provide off-street space for more than 1,100 cars.

Co-ordination Needed

It should be obvious from these illustrations that traffic and highway planning must be co-ordinated with urban renewal planning so that physical results are in harmony with the community's ob-

Figure 1. Norfolk, Virginia—Existing conditions in urban renewal area.

Figure 2. Norfolk, Virginia—Projection of highway improvements from urban renewal: extension of Brambleton Avenue to a junction with Hampton Boulevard and Virginia Beach Boulevard (upper left).

Figure 3. Oak Street Redevelopment Area and route of the Oak Street Connector to the Connecticut Turnpike. Solid line indicates boundary of Oak Street Area; dotted line, the highway location. At lower right, is Grace-New Haven Community Hospital and Yale Medical School.

Figure 4. Oak Street Area cleared, highway frontage roads constructed.

jectives. But if more conclusive evidence is needed, the Butler Street project in Atlanta, Georgia, provides it. In this case the proposed reuses and street system within the project area are completely integrated with the complex interchange of two expressways. Certainly the planning for the urban renewal area could not have proceeded independently of the planning for the expressways, and vice versa.

There are problems of co-ordination other than in planning the physical relationships between highways and urban renewal. There is the problem of timing urban renewal activities with highway activities in order to prevent the improvements created by the one from unnecessarily raising land values—and thus land acquisition costs—for the other.

There is also the serious problem of co-ordinating urban renewal and highway activities to minimize the problem of re-locating displaced families. The magnitude of the problem is evidenced by the following nationwide estimate of the number of families that may require re-locating for fiscal years 1958 through 1960: urban renewal, 83,000; highways, 75,000; other, 89,000 (total, 247,000). Certainly a community must plan and program its re-location requirements to avoid undue strain on its housing resources.

Lessening Re-location Problems

When expressway land is obtained through an urban renewal project, assistance is available for re-locating the displaced people—assistance that is presently not available under independent highway right-of-way acquisition. Under federal law a locality must offer re-location in decent, safe, and sanitary quarters to all families displaced from an urban renewal area, including parts of such areas that are acquired for eventual disposition for highway purpose. Local urban renewal authorities provide assistance to families in finding such housing. They may also provide moving expenses up to $100 for each family and up to $2,500 to each business for actual moving expenses and loss of property if displacement is caused by urban renewal project activities. These costs are covered wholly by federal grants.

Problems of re-locating families displaced by highway construction in urban areas may also be alleviated through the assistance

of liberal mortgage terms under Federal Housing Administration Section 221 mortgage insurance. Section 221 insurance, although it was conceived as an aid to re-locating families displaced by urban renewal activities, may be authorized for use by families displaced by the construction of public works and highways outside of urban renewal areas.

The need for co-ordination between urban renewal and highways is an accepted fact at the federal level. The Federal Aid Highway Act of 1956 greatly increased the federal government's responsibility in urban highway programs, and there has been an increasing awareness of the impact of federally aided highways on the whole urban structure. The Urban Renewal Administration and the federal Bureau of Public Roads, which administers the highway act, are co-ordinating policy and procedures with respect to their activities.

State and local authorities have been advised on the need for co-ordination and on procedures to be followed. For example, application for urban renewal projects must include a map showing the location of major highways (including federally assisted highways) that are under construction, being planned, or contemplated. A copy of this map, which also shows the urban renewal areas, is forwarded to the appropriate Bureau of Public Roads division office.

Of course, many urban renewal areas are not directly involved with major highways or significant parking facilities. But in all areas, street and traffic considerations play an important role in formulating the urban renewal plans. This role is perhaps obvious when it is remembered that obsolete street patterns and detrimental traffic conditions are often a major cause of the existence of slum conditions in the areas.

In areas involving considerable clearance, a new street pattern, based on modern principles of street planning, is usually established by the urban renewal plan. Where off-street parking and loading facilities are not to be provided as specifically located and designed elements, the plan usually requires the redevelopers to provide for such facilities—clearly an aid to future traffic movement. The two downtown projects in Norfolk will eliminate more than a quarter-mile of narrow, congested streets in addition to numerous lanes and alleys.

The street layout established in the urban renewal plan will consist of fewer, but wider, streets which—because the project will provide a large amount of public and private off-street parking space—will be used primarily for moving traffic. Many projects planned for residential redevelopment will wipe out obsolete gridiron patterns and replace them with curvilinear systems such as are found in the best of suburban subdivisions.

The feasibility of the industrial park development planned for the Kenyon-Barr project in Cincinnati is dependent in great measure on the access provided by the proposed Mill Street expressway. The importance of this relationship was recognized when plans for the Sixth Street expressway were modified to provide interchanges with project streets.

Traffic Engineering Ingenuity Needed

The principle of using superblocks as a means of clearly separating vehicular from pedestrian traffic has also been recognized in urban renewal planning. For example, Detroit's Gratiot project will convert a slum area of about thirty small blocks into a ninety-acre superblock penetrated at intervals by cul-de-sac streets. The plan for renewing the central business district of Fort Worth, Texas, without federal aid, uses the same basic principle, in that objectionable vehicular traffic will be eliminated from the center and enormous parking facilities will be located at its fringe.

Those areas where rehabilitation is the predominant urban renewal activity and where a majority of the structures will not be cleared also involve complex street problems. To reduce the friction between traffic and a residential environment calls for great traffic engineering ingenuity when the basic existing street pattern must be retained. It is sometimes possible to close off segments of certain streets without losing necessary access but with a reduction in unnecessary traffic conflicts.

The Bayside Park project, a fifty-seven-acre rehabilitation undertaking in Portland, Maine, is a good illustration. By closing short sections of streets at six key places a grid pattern will be partially converted into a system of loop streets that should effectively reduce the conflict between traffic and a residential area. Plans for the

Mack-Concord project in Detroit call for the use of ingenious "traffic diversions" at appropriate intersections. These will in effect break up the raceways in a gridiron street pattern. The plans for the same project propose to transfer curb parking to parking bays constructed in alleys in the centers of blocks.

There is a need for more traffic engineering ideas such as these to assist in solving traffic problems in rehabilitation areas. So, despite the spectacular rebuilding being done in parts of our cities, there is continuing need for traffic and highway engineering skills that will get better use of the existing street systems in other segments of cities.

It is sharply apparent that the planning of highways, as well as schools, parks, and other community facilities, and the planning of urban renewal projects are so interdependent that one cannot logically proceed without the other.

The development of urban highways and urban renewal projects are both very expensive processes. We cannot afford, then, the costly mistakes that will unquestionably result from unrelated programs—unrelated to each other or to carefully prepared overall city and metropolitan general plans. The highway planner and the urban renewal planner must join together in approaching the problems and plans of the entire community if success is to result.

Correction for October 1958 issue

In James S. Burch's article, "Ten Year Traffic Trends," the second sentence in the third paragraph on page 482 should have read: Reliable data now available show that for the last few years we have had actual reduction in travel per vehicle and in gasoline consumption per vehicle.

The last sentence in the fourth paragraph on page 484 should have read: Even a three-and-a-half percent a year growth means a one hundred percent increase in about twenty years.

A Freeway System for California

SENATOR RANDOLPH COLLIER

State Senator Randolph Collier (R) has served continuously in the California Legislature since 1938. He co-authored the "Collier-Burns Highway Act of 1947," served as chairman of the Joint Interim Committee on Highway Problems and the Senate Interim Committee on Transportation Problems. He is a member of the California Commission on Interstate Co-operation, Western Interstate Committee on Highway Policy Problems, and chairman of the Subcommittee on Legislative Problems on Highway Operations.

THE effort to keep abreast of California's burgeoning population and traffic volumes involves constant review and adjustment of policies of highway management and finance. Reportedly a first in the nation, California is taking steps to set up a state-wide freeway system of more than 12,000 miles estimated to cost almost $10.5 billion (at 1958 prices).

This article reviews the legislative background leading to the current proposal, the procedures and results of the study, and speculates on the next steps necessary to meet the demands of California motorists for safe, convenient and economical highway transportation.

Need for a New Approach

A number of factors may be offered in explanation. First, our highway programs of 1947 and 1953, impressive as they seemed at the time, were completely insufficient to the growth experienced. For example, the forecasts on which our 1947 program was based now appear ridiculously low. We expected to have a population of 13,200,000 in 1970; we passed this figure in 1956—in ten instead of twenty-four years. In 1946 we had three and a half million motor vehicles and were expected to have about five million in 1957. We had more than six and a half million. Our motor vehicles today run up a total of about sixty-five billion vehicle miles —a volume of traffic that was not supposed to come along for at least another twenty years. Highway construction costs were expected to drop, but they have more than doubled.

The fact is that during the ten years since 1947, California made an impressive record in the development of its state highways, county roads, and city streets. None of us could visualize what our traffic conditions might have been had it not been for this ten years of sustained progress. Yet when we looked at the problems remaining, it seemed as if we had been standing still. The plain fact is that the explosive growth of traffic and the upward spiral of costs had all but nullified the best efforts of our engineers, with the result that highway transportation continued to be hazardous, frustrating, and uneconomical. It was clear that the legislature must intensify its efforts and devise a new departure.

One of the problems before the legislature for many years was the need for an adjustment of the state highway system, particularly in metropolitan areas. Many of the demands for the addition of mileage to the state highway system appeared to be quite legitimate, but no conclusive tests of eligibility had been devised. Moreover, in the absence of a uniform state-wide approach the legislature believed that piecemeal additions would create an unbalanced program and would distort the financial program.

Another problem arose from the increasing opposition to specific locations of freeways in some of our metropolitan areas. It was felt that part of the opposition might be attributable to the fact that the state had no overall system of freeways to lay before the public, showing the ultimate objective of the freeway program. Instead, we were locating and building scattered miles of freeways on a piecemeal basis, without demonstration that they were part of an overall plan to provide a basic transportation system for the entire state (although, in fact, such a system was emerging).

It was thought that a lesson might be learned from the ready public acceptance of the national interstate highway program, probably due in part to the fact that a definite system could be portrayed on maps and could easily be visualized by the public as a master plan of interstate transportation arteries for the entire country.

Another consideration was the large increase in federal funds that California could expect as a result of the Federal Highway Act of 1956. It was obviously necessary to reconsider our entire financing program in order to absorb the federal program and still continue to make the wisest possible use of the total resources available for highways.

Actually, the people had already demonstrated their approval of freeways. Other than the understandable, if difficult, controversies over specific locations the general demand was for more rapid construction. We already had more freeways than other states but they were badly overcrowded, which simply proved to us that their value was appreciated. We knew that freeways work—that they are safer and more economical. So it seemed that the time had come to project a *system* that would improve the operations of each of the segments.

Senate Concurrent Resolution No. 26

On the basis of these and other considerations, the California Legislature in 1957 enacted Senate Concurrent Resolution No. 26, from which the following legislative findings may be quoted:

(a) Adequate, safe, and economical highway transportation is vital to the future development of the State of California.

(b) It has been amply demonstrated that properly designed and located freeways and expressways are the most economical means of providing highway adequacy and safety.

(c) California is rapidly developing individual freeways and expressways and segments thereof, but in many cases on a piecemeal basis, which program has been greatly accelerated by the enactment of the Federal-Aid Highway Act of 1956 and will be expanded considerably more if Congress carries out its stated intentions regarding apportionments of federal funds for interstate highways.

(d) There is need for the people of California and its agriculture and industry to be informed of plans for the ultimate freeway and expressway system of the entire state, as nearly as such can now be determined by basic engineering studies.

(e) There is need for the establishment of a plan for such a state-wide system of freeways and expressways determined without regard to present jurisdiction over the highways, roads, and streets that might be included, in order that appropriate state, county, and city transportation plans and fiscal arrangements may be worked out and properly co-ordinated.

After this recital of findings, the resolution called upon the department of public works to "undertake a study which will provide a basis for an overall state-wide plan of freeways and expressways for the State of California, such study not to be limited to state highways and such study to locate the potential freeway and expressway routes of such a state-wide system and the necessary connections

thereto as nearly as is practicable in advance of detailed engineering design of projects."

It may be said that consideration had been given to the possibility of having the study done by outside consultants rather than our own highway agency, but after investigation the idea was rejected because of the magnitude of the task, the time limitations of the study, and the simple fact that our own agency was in the best position to utilize the vast quantities of data that had already been assembled in highway planning over the years.

However, the department was advised to employ engineering consultants and other specialists at its discretion. It subsequently arranged with the Automotive Safety Foundation of Washington, D.C., and the Institute of Transportation and Traffic Engineering of the University of California for advice on overall aspects of the state-wide study. It also made arrangements with a number of counties and their incorporated cities for the joint employment of engineering consultants to draw up comprehensive highway, road, and street plans, including the freeway requirements, for particular sections of the state.

The Advisory Committee. SCR 26 also provided for the creation of a committee of seven county and seven city officials to act in a technical advisory capacity to the department in the conduct of the freeway system study. The committee had more than usual status as it was appointed directly by officers of the state legislature. Fortunately, as it turned out, this provision may become one of the most important by-products of the entire study. For it is the first time, to my knowledge, that such co-operation in highway planning between state and local officials has been achieved in California, and perhaps in any other state.

In presenting its final report, the state reported anent the advisory committee:

> This committee has been of valuable assistance to the department in carrying out the intent of the resolution. The committee offered suggestions on the general features of the study, recommendations on phases and conduct of the study where local jurisdictions were affected, comments and constructive criticisms as results became available, and suggested guidelines of policy concerning development of the freeway plan.

In similar vein, the advisory committee highly commended the staff of the department.

It is my sincere hope that the co-operative effort demonstrated in the instant study is but the beginning of a new era in intergovernmental relations in California.

Conduct of the Study. It is not my purpose here to describe study procedures in detail. It should be said, however, that the department made full use of its district machinery, which solicited advice and recommendations of all the local areas of the state, and transmitted data along with recommendations to the central office in Sacramento. At headquarters, all of the planning information of local areas was utilized in appraising the recommendations, and finally the system was selected after having been reviewed by consultants and the advisory committee. Not only was an attractive report issued, but colorful exhibits, slides, and aerial photographs were prepared for presentation of the results of the study to the legislature and the public. The report was presented to the Joint Legislative Committee on Highway Problems on September 3, 1958.

Results of the Study. While many facts could be taken from the report itself demonstrating the need for a freeway system of the magnitude outlined, perhaps the outstanding point is the need for expansion of our highway capacity to provide for anticipated growth in California. It is estimated that California's population will grow from fourteen million in 1957 to thirty-one million in 1980; that motor vehicle registrations will increase from seven million to seventeen million; and that volumes of highway traffic will *triple* by 1980.

The department estimates that the selected freeway system, which incidentally includes highways that will ultimately be full freeways but will initially be expressways in a stage of construction by 1980, will carry about fifty-nine percent of all highway, road, and street mileage in the state. Even in the Los Angeles metropolitan area where, of course, there will be large volumes of local-access movements, the proposed freeways of the selected system are expected to carry more traffic than all other miles of highways, roads, and streets combined.

The department attributes the following service features to the proposed system:

The system will serve directly or closely, all population centers estimated to reach 5,000 or more people by 1980.

It serves directly, or will absorb a large proportion of all major rural

traffic streams estimated to exist in 1980, and will relieve for local use the most congested city streets by removing the longer distance through-traffic.

It will protect the investment in highways and preserve the capacity for carrying traffic through application of planned access control, according to developing needs.

The system should reduce highway fatalities by sixty to seventy-five percent for the traffic using it, when developed to full freeway standards.

The system should save appreciable amounts of time, reduce commercial operating costs and expand market areas.

It should aid the division of highways in detailed planning and design of specific sections of the system, and enable the state, counties and cities to co-ordinate and develop their future planning and programming of transportation facilities.

It should aid in the more effective use of funds that will be available for highway purposes at all jurisdictional levels.

The Financial Picture. Although not an official part of the study, estimates of costs and available revenues were also prepared at the request of the Joint Committee, and these are presently being analyzed by our economic consultant.

Total costs of the freeway system at 1958 prices are estimated at $10.5 billion, of which $1.8 billion is for 1,519 miles of roads and streets which are not now in the state highway system. Preliminary estimates of benefits to highway users indicate that they will exceed costs by more than two to one.

The estimate of revenues indicates that the entire freeway system plus the remaining mileage of the state highway system (which are not visualized as freeways but are clearly of state importance) can be financed with funds that are now in sight at existing rates of user taxation and anticipated levels of federal aid. However, there is a close fiscal balance and it will be up to the legislature to decide whether or not to give top priority in financing to the freeway system. For if the freeway system is to be adopted and actually constructed it will not be possible to do much else under present financial arrangements.

The Task of the Legislature

The joint interim committee on highway problems is holding hearings throughout the state to ascertain public reaction to the proposed freeway system. The hearings have not been completed, nor the results fully evaluated at this writing. However, preliminarily

it may be said that the public reaction has been one of general approval. If anything, there has been some criticism that the proposed system is not extensive enough; that it does not provide for *ultimate* needs. Some concern has been expressed lest immediate adoption of the total freeway system might delay projects that have been in the mill a long time and have immediate prospects of financing.

One thing that has been made abundantly clear in our hearings is the need for periodic review of the program at rather frequent intervals. It has been impressed upon us that a plan must be a living thing in a dynamic economy like ours.

It also appears to me that there is a next logical step in our highway planning. Even though we may give priority to the selected freeway system at this time, we cannot put off consideration of local road and street problems, which we know to be critical in some areas, for another twenty years.

The proposed freeway system takes off the top-priority layer of our total road plant. Once the freeway system is adopted, the next logical step will be to continue our planning to provide for a supplementary system of expressways and major connectors to the freeways. In any subsequent study the state-county-city co-operation exemplified in the SCR 26 study should be continued. A comprehensive road and street classification survey, based on the existence of the California freeway system, together with controlled, uniform, and reliable estimates of costs will give the legislature a sound factual basis for consideration of additional financing should the need be demonstrated.

We should look upon the proposed freeway system as the first step in the development of new concepts of highway management and finance in California. If we follow through in logical progression I am sure that California will be equal to the tremendous challenge to provide adequate transportation to meet its expanding economy.

To the few critics who have suggested that the proposed freeway system is a "pipedream," I would answer in the words of David H. Burnham in 1927:

> "Make no little plans—they have no magic to stir men's blood and probably themselves will not be realized. Make big plans, aim high in hope and work, remembering that a noble, logical diagram once recorded will never die—but long after we are gone will be a living thing asserting itself with ever-growing insistency."

Freeway Entrance and Exit Controls

ALFRED BERARDUCCI AND JOHN J. DOBELEK

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RELIEF of urban traffic congestion urgently requires the highest priority because increasing congestion occurs not at infrequent intervals, as in rural areas, but twice daily, the year-round. Modern-type highways and their related feeder systems will contribute importantly in solving urban traffic problems. The freeway is intended to offer the safety, convenience and ease of operation unobtainable on ordinary surface thoroughfares.

Public acceptance of this type of facility, however, will be measured by its superior traffic-carrying characteristics. If these superior characteristics are not apparent, we may expect continued complaints from the traveling public. Public acceptance is necessary, since funds for these high-cost facilities come from the public, regardless of the method of taxation.

The satisfactory operation of a freeway depends largely on the adequacy of its entrances and exits. This cannot be too strongly emphasized. Experience gained in communities where freeways are in operation, indicates that entrances and exits are by far the most important consideration in design. If entrances and exits do not

operate efficiently, there is likelihood of the freeway's failing as a superior highway.

Freeways in highly developed urban areas are roads of specialized design affording safe, fast, unobstructed movement on principal routes of travel. The immediate objective is to give different sections of the city easy and efficient connection with one another, and to provide efficient connections with the arterial and trunkline systems of the metropolitan area. This is the modern freeway, also known as a limited-access highway.

The modern freeway can virtually free the street system from congestion and accidents, and handle large volumes of traffic safely and expeditiously, principally because it can separate local traffic, or short-distance travel, from long-haul travel. Freeways can permit the local street system to function in an efficient manner, free of heavy through-traffic movements.

A freeway, accordingly, is a thoroughfare with no traffic signals, no intersections at grade, with opposing traffic streams separated, entry and exit limited to predetermined locations. Cross traffic is provided for at reasonable intervals carried over or under the freeway. The urban freeway is for continuous movement of traffic through and around a city, unhampered by start and stop driving, parking, or pedestrian problems, with accidents greatly reduced.

Access from abutting property is limited. Parallel frontage streets are provided along margins of the right of way to serve the abutting property and local traffic. Ramp connections to important cross streets will engage the existing street system for collecting and distributing freeway traffic. At intersections of two freeways, a much more elaborate type of traffic interchange is usually required. Thus, the freeway will carry the major traffic for a wide adjacent band through the city.

Planning the System

The first step in planning a freeway network should be a comprehensive origin-and-destination survey amply detailed to provide an accurate picture of travel habits and desires. This survey should then be expanded to include variations due to changing land use and area growth. The selection of freeway routes should be based on the present and future desires of traffic in the area.

The information should be in sufficient detail to aid in locating exit and entrance ramps that best serve the area. Expected traffic volumes should be determined; the design and number of ramps should be adequate.

In rural areas, entrance and exit facilities for limited access highways are provided at widely spaced intervals, the frequency of these access points being measured in miles. The locations are determined by the need, which in turn is determined by the origin and destination of vehicular movements. In cities and in urban areas generally, these access facilities should be spaced more frequently, and the distances between them is usually measured by block lengths or fractions of miles. Again, the origin and destination of traffic will determine the frequency and location of these access points.

Since the construction of a complete network of freeways in an urban area usually extends over a considerable number of years, interim traffic estimates should be made for portions of the network as they are opened for traffic. Completed parts of a system will have higher volumes than anticipated when the system is completed. This requires the planning of exit capacity and location based not only on future volumes when the network is finished, but also on the highest volume expected during construction of the network.

Locating the Ramps

Although a series of successive streets may pass over or under a freeway, not all these streets can be served by ramps; nor would it be desirable. Consistent with major street patterns and traffic desires, the spacing between ramps must be ample to permit proper operation between exit and entrance.

Examination of the street pattern in metropolitan areas usually reveals a lack of uniformity or systematic arrangement of streets. This may be due to a number of reasons, but in general, most cities expand and develop as circumstances demand. Topography and other physical features certainly were important in determining the physical layout of the street pattern. Nevertheless, for practical and economic reasons, city developers and city fathers of the past tended to take the line of least resistance in making important decisions in street design and layout.

These are matters of timing, and since cities develop in stages, the street system also developed in stages. Thus, the freeway planner will find he has no uniform street pattern to work with but a conglomeration of arterial, major, secondary, and local residential streets. Through this haphazard system, he is compelled to fit his modern highway. He should bear in mind that drivers who will use this highway live, work, and do business along the area through which the highway passes.

Thus, there will be the need for entrances and exits to serve these requirements. But these access points should be located so as not to interfere with one another or create more confusion than they are intended to eliminate. Unless an up-to-date city plan is available, a study of a city's traffic patterns, volumes, and turning movements should be made, to indicate which are the arterials and major streets. These streets should be interconnected with freeway traffic.

They are the feeders of the freeway, and are fed from major traffic generators in a metropolitan area. The generators may be the factory and industrial areas, the commercial and business districts, the shopping centers, the parks and schools, the off-street and on-street parking areas, and the residential areas.

It may be desirable to provide ramp connections to all major streets intersecting the freeway path. This will depend largely on the master plan for thoroughfares in the city. Construction of the freeway system may provide an added opportunity for the gradual redevelopment of a city. Since the street pattern is the framework of the city, it is the basis for the land-use planning, and the basis for rebuilding and reconstruction of parts of a city. Consultation and co-operation between highway planners, traffic engineers, and city planners is indispensable.

Entrance Ramps

An acceptable pattern of ramp connections will include sufficient entrances and exits to satisfy the traffic volumes desiring to enter the freeway and should take into account the route of the freeway, the type of traffic it serves, and the origin and destination of that traffic.

The spacing of entrance ramps varies with the demand of traffic. In the central business district, ramps and connecting streets should

be numerous enough to provide direct access from all parts of the district, eliminating additional travel on already congested streets.

At the periphery of the city where routes change from limited access to local service, the local surface street should be adequate to serve as a collector for the freeway. Entrances should have capacity for smooth transition from streets to freeway. Since most trips are round trips, there should be entrance and exit ramps in the same area.

Locating Exits

Streets served by an exit from a limited-access facility can usually be expected to increase in traffic volume. Care should be taken to insure that the exit is located near a street capable of bearing additional traffic. This can be accomplished if a detailed master plan of traffic ways is available.

The capacity of collector streets should be increased to accommodate the additional volumes certain to occur. Available traffic control procedures should be employed. With the failure of these, physical widening of the street must be considered. This widening should extend far enough to prevent undue congestion for entering or exiting traffic.

Locating exits in advance of the major street provides a direct route to the major street. In the case of depressed-type freeways, it eliminates the necessity to provide a deceleration area under a bridge that may increase the length of the bridge and could result in poor visibility of the ramp. This eliminates the likelihood of drivers' using the minor street to by-pass the intersection of the ramp and major street, a practice which could lead to considerable dissatisfaction in the surrounding neighborhood.

An exit ramp should be located a sufficient distance beyond an entrance ramp to minimize the effect of the *exiting* traffic weaving with the entering traffic. If this cannot be done, the possibility of providing a roadway separate from the main line should be investigated to provide for the weaving out of the main traffic flow.

Where it is necessary to have two exit ramps in succession, they should be far enough apart for adequate signing to avoid the likelihood of a driver's exiting on the wrong ramp. If this is not practical, the two exits should be combined and traffic divided on the ramp.

Distances referred to between ramps will be dependent on the design speed of the freeway.

Ramps in Congested Areas

Since the cost of widening streets in congested areas is prohibitive, freeway entrance and exits should be located at streets not operating near capacity or that can be improved by traffic control procedures, such as parking restriction or changing to one-way. These streets should be long enough to provide cross streets to distribute freeway traffic adequately.

Streets leading directly to parking facilities do much to provide a smooth flow in congested areas. When a pair of one-way streets is used to provide service to and from the freeway, the provision of parking facilities between the one-way streets is advantageous to smooth and rapid removal of traffic from the congested area.

There should be ramps enough in congested areas to provide uniform dispersion of the freeway traffic throughout the area, and to avoid the need for excessive out-of-way travel, since excessive out-of-way travel adds to the congestion.

Capacity Considerations

Exit ramp capacity is determined by the capacity of the area of departure from the freeway. Studies have shown that a one-lane take-off has approximately the same capacity as a two-lane take-off unless a lane is dropped from the freeway at the exit ramp.

A direct-connection ramp usually has more capacity than an indirect or cloverleaf type, because of higher operating speeds that are possible from the flatter curvature. All ramps should be of sufficient width to allow the passing of disabled vehicles. With long ramps, the width should be sufficient to allow passing of a slower moving vehicle for unrestricted flow.

In Detroit practice, a single-lane ramp is twelve feet wide with two-foot gutter pans on each side, together with a mountable curb on one side and an all-weather shoulder. This arrangement provides the space needed to pass a disabled vehicle, without encouraging unnecessary and hazardous two-lane usage at the take-off.

Capacity of the first signalized intersection beyond exit ramps should be large enough to accommodate the *exiting* traffic plus local traffic on the service road. It should have ample storage space to prevent a backup from extending into the freeway.

Local Street Capacity

It is necessary occasionally to make local street improvements for some distance from a freeway to insure the necessary capacity to handle the added volume from an exit ramp. In many cases, the failure to widen or otherwise improve the surface street that receives ramp traffic will cause a breakdown of the freeway operation. Service roads of considerable continuity often aid in the distribution of exiting traffic to more than one major street.

Because of construction time involved in urban areas, it is impractical to complete a freeway route in its entirety without opening intermediate sections to traffic. Consequently, the construction schedule should be planned to provide temporary endings at ramps that serve a street pattern capable of dispersing high traffic volumes.

Ramps that serve as temporary endings should be designed to allow temporary widening to a minimum of two lanes.

Straight Ramps

Straight ramps are probably the most economical to build, since they use less room and require less additional right-of-way. Usually they can be built in little more than the area normally used for slope on a depressed-type freeway. The width of straight ramps can usually be less than on curved ramps with the same minimum clearance and passing conditions.

Operationally, the straight ramp has the advantage of higher design speed which allows some deceleration on the ramp. Higher design speed and more freedom of operation give higher capacity.

Cloverleaf Ramps

The radius of curvature of curved ramps generally is the determining factor in the needed amount of additional right-of-way. For

that reason, the radius is usually held to a minimum, resulting in a sacrifice of operating speed and ease of driving.

Where high volumes are expected, the use of curved ramps usually does not serve as well as straight ramps, the exception being a curved ramp from a left exit that provides for a direct movement.

Since the width necessary to pass disabled vehicles on a ramp is, to a degree, a function of the radius of curvature, the width of curved ramps is in most cases necessarily wide.

Where there is sufficient right-of-way, and traffic volumes are not excessive, a cloverleaf ramp provides a satisfactory method of handling left turns from a freeway to another high type facility.

Curved-Straight Ramps

A curved-straight ramp usually takes off to the right in much the same manner as a straight ramp, and then is curved near the top to pass over the freeway, normally on a separate structure.

This is frequently used where a direct movement is desired for left turns from the freeway without the use of a left take-off. Many times both the right and left turns are taken off in the straight portion of the ramp and then separated before reaching the curved portion.

This type of ramp combines the speed and decelerating characteristics of a straight ramp, and the direct connection characteristics of left-exit curved ramps.

Right and Left Entry and Exits

In most cases, exits to the right are preferred, primarily because the average speed of traffic in the right lane of a freeway is usually lower than in the left lane. Since speeds are lower, the risk of rear-end accidents due to deceleration is less. Also, since it is preferred that trucks and other slow moving vehicles drive to the right, this eliminates the need for their crossing the faster moving lanes to exit.

When the use of a left-exit is unavoidable, extra care should be used to insure ample deceleration area separate from through-lanes. If most of the preceding exits have been to the right, extra signing may be necessary to inform the driver of the left-exit. A left-exit

should be a sufficient distance from a preceding right entrance to allow ample room for a driver to weave across the through-lanes to reach the exit without interfering with the flow of the main line. This is also true where a left entrance precedes a right-exit.

Signing of Exit Ramps

Proper signing is an important consideration in operating the entrance and exit facilities of a freeway. Large overhead signs, easily read, and of distinctive color, will simplify the driver's problem. Advance signing should be adequate to allow a vehicle to weave across the entire width of the freeway without changing speed or being forced to accept an unsafe gap in traffic.

Since the speeds on freeways are usually high, the length of time the driver has to read a sign is limited. For that reason, the message should be clear and short, with the letter-size large. Care should be taken in the location of signs to insure that their visibility is not limited by physical features of the freeway such as bridges, vertical or horizontal alignment, or other obstructions. All signs should be legible at night.

In an urban area, a typical exit signing series would consist of the following:

At preceding exit, a sign informing the driver of the name of the next exit.

At a minimum of 1,000 feet in advance of the deceleration area, a sign giving the name of the exit and the information to "keep right" or "left."

At the beginning of the deceleration lane, a sign giving the name of the exit with an arrow pointing in the general direction of the ramp.

On the nose, a sign with the word "exit," or the name of the exit with a horizontal arrow pointing to the exit. This sign not only helps guide the driver; it also increases the visibility of the nose.

As exits become more numerous, it becomes increasingly difficult to inform the driver adequately to allow him sufficient time to reach his proper exit safely. When this occurs, it is sometimes necessary to include the names of the two succeeding exits on one sign with the direction to keep right or left.

Nose Design: The freeway nose of an exit ramp should be off-set a sufficient distance from the through-lanes of the freeway to allow any driver mistakenly within the deceleration area of the ramp to return to the main line without crossing the nose.

The nose should be kept free of such rigid structures as light poles, bridge piers, exposed guard rail ends, or any object that would cause severe damage to a vehicle if struck.

The curb at the nose should be rounded and the nose paved to allow a driver who inadvertently runs onto the nose an area of recovery.

Ramp Grades: On depressed freeways, the ramp grades produce a desired effect on exiting traffic since the ascending grade assists the deceleration of traffic. Accordingly, the ramp grade should be as great as possible, with truck operation and snow and ice conditions the limiting factors.

On elevated freeways, the ramp grade acts against the desired deceleration. In this instance, the descending ramp grades on elevated freeways should be as flat as economically possible.

Usually a steeper grade can be allowed on a straight ramp than on a curved ramp. This is because of the higher design speeds on straight ramps.

Visibility of Exit Ramps: For maximum visibility, the nose of an exit-ramp should be in advance of the crest of vertical curves, and should not be situated on horizontal curves where sight distance is limited.

The location of exit-noses following bridge piers or abutments sometimes leads to visibility restrictions. Visibility at the end of the exit-ramp should be adequate for safe operation at the first crossing on the local street system.

Example of Actual Practice

We have discussed general design considerations for freeways in urban areas. To illustrate the application of these principles in the design of a freeway, we shall describe the John C. Lodge Expressway[1] in Detroit.

1. Although officially called an expressway, this highway fits the nationally accepted definition of a freeway.

This freeway originates near the northern boundary of the city, adjacent to suburban communities largely residential in character. After collecting traffic from the suburban communities, this route passes through a large residential area of the city proper, and continues through light commercial development, mixed with light industry. It finally penetrates the city's central business district after passing along one edge.

During morning peak hours, substantial volumes from the suburbs enter the freeway at its outer extremity by means of a major street connection, the James Couzens Highway—a divided eight-lane street. Much of this traffic is bound for various sections of the central business district. As the freeway continues through the city's residential area, additional traffic bound for the central business district enters.

A series of entrance and exit ramps is required to collect and disperse this traffic. The location of these ramps was determined by a careful study of the city's major street system and the desires of the traffic as determined from a comprehensive origin-and-destination study. The actual location, daily usage, and distances between ramps are indicated in Table I.

It will be noted from this table that, as the central business district is approached, the entrances and exits are more frequently spaced to serve the predominant traffic movement. In planning the collection and dispersion of traffic in the central business district, the capacity and usage of the surface street system was considered.

Every effort was made to avoid connecting main arterials directly to the freeway. Streets with high capacity, but with low volumes, were selected to provide the connectors.

Outstanding examples are provided by the difference in volumes on streets such as Bagley Avenue and Howard Street. The extreme lower end of this freeway is not yet opened to traffic. The opening is scheduled to coincide with the completion of certain buildings in the Civic Center Area north and south of West Jefferson Avenue.

Additional ramps for exiting traffic will be provided at Larned (a one-way street), and at Jefferson (a divided highway), and directly into underground and roof parking facilities to be built as part of the Civic Center, containing 2,550 parking spaces. Additional

Table I

LOCATION, 24-HOUR USE AND DISTANCE BETWEEN RAMPS, JOHN LODGE EXPRESSWAY

Northbound				*Southbound*			
Ramp	*Use*	*Accumulation*	*Distance (feet)*	*Ramp*	*Use*	*Accumulation*	*Distance (feet)*
Abbott (on)	21698			S. B. Wyoming (on)	2631	29681*	
		21698	1000				
Vernor (off)	314			N. B. Wyoming (on)	1990	32312	600
		21384	300				
Bagley (on)	11136			Greenlawn (on)	1699	34302	2400
		32820	1600				
Vernor (on)	7778			Livernois (off)	5105	36001	1000
		40598	1500				
Temple (on)	11240			S. B. Livernois (on)	3966	30896	500
		51838	3300				
Forest (off)	1917			N. B. Livernois (on)	1398	34862	1200
		49921	1300				
Forest (on)	10038			Linwood (off)	4587	36260	2000
		59959	1400				
E. B. Ford (off)	5858			Linwood (on)	3036	31673	1700
		54101	100				
W. B. Ford (off)	16223			E. B. Davison (off)	3538	34709	4300
		37878	1600				
W. B. Ford (on)	16642			W. B. Davison (on)	9097	31171	900
		54520	200				
E. B. Ford (on)	15969			E. B. Davison (on)	4965	40268	100
		70489	1300				
Milwaukee (off)	9652			Glendale (on)	6506	45233	1200
		60837	2000				
W. Grand Blvd. (on)	9412			Elmhurst (off)	1734	51739	1200
		70249	1600				
Seward (on)	3171			Webb (on)	6014	50005	2000
		73420	1800				
Clairmount (off)	5079			Chicago (off)	2051	56019	1400
		68341	900				
Hamilton (off)	7052			Chicago (on)	4204	53968	1500
		61289	2200				
Chicago (on)	2346			Clairmount (on)	7577	58172	1900
		63635	1600				
Webb (off)	5824			Pallister (off)	3603	65749	200
		57811	1100				
Webb (on)	1480			W. Grand Blvd. (off)	7296	62146	900
		59291	1800				
Glendale (off)	4497			Milwaukee (on)	9859	54850	1900
		54794	1100				
E. B. Davison (off)	10876			W. B. Ford (off)	16165	64709	1500
		43918	1100				
W. B. Davison (off)	4852			E. B. Ford (off)	11451	48544	100
		39066	300				
W. B. Davison (on)	5425			E. B. Ford (on)	19612	37093	1400
		44491	4200				
Linwood (off)	3966			W. B. Ford (on)	5077	56705	900
		40525	1500				
Linwood (on)	5346			Forest (off)	10609	61782	1500
		45871	1900				
Livernois (off)	5589			Forest (on)	1687	51173	1300
		40282	400				
N. B. Livernois (on)	3179			Grand River (off)	7961	52860	3300
		43461	1400				
S. B. Livernois (on)	867			Vernor (off)	8658	44899	1500
		44328	1200				
Greenlawn (off)	4341			Bagley (off)	14321	36241	1500
		39987	2400				
Wyoming (off)	4353			Vernor (on)	436	21920	400
		35634*					
				Howard (off)	22356	22356	1400

*Counted at James Couzens

entrance ramps will be located at Congress Street (a one-way street), and from Jefferson Avenue (a divided eight-lane highway).

An important consideration in the planning of these routes in concentrated areas is the location of off-street parking in relation to ramps. The use of one-way streets directly connected to entrance and exit ramps is well illustrated. The Bagley Avenue ramp was designed to connect directly to a recently completed two-level underground parking garage under Grand Circus Park, which provides for 1,025 parking spaces.

A two-story above-ground parking garage was erected between the Abbott Street entrance ramp and the Howard Street exit ramp. This parking garage provides 605 parking spaces. A two-level underground parking garage containing 700 parking spaces was built at the Ford Auditorium south of Jefferson Avenue, which will be served from the Jefferson Avenue ramp. Incidentally, these parking structures have done a land office parking business since their opening.

Additional parking will be provided in structures now being erected, and will be available when the extreme lower end of this freeway is completed. Direct connections are available to these structures by means of one-way streets, or direct off- and on-ramps.

Detroit's freeways have been under constant study by highway and traffic engineers. Although a few changes in some design details will be made in future freeways, it is believed that the basic design is good. They are so popular with the motorist, however, that they are already carrying loads beyond their design capacity. Under these conditions, the slightest mishap or vehicle breakdown can cause an almost immediate stoppage of traffic.

Control and Operation

There must be developed a system of surveillance to enable the immediate detection of trouble, its location, and cause. This must be supplemented by a communications system and a method of lane and ramp controls to clear the congestion and allow traffic to move again as quickly as possible. Detroit's recent experiment with a limited television system, and some direct telephone connections with police and maintenance officers, indicates that surveillance by

closed circuit television offers excellent opportunities for the development of a control system to help insure an efficient use of these freeways.

But no matter how well designed a freeway may be, there are other factors to consider in its operation. The human element cannot be ignored. The motorist should learn that driving on freeways is somewhat different from driving on surface streets. Heavier volumes and faster speeds demand constant attention and greater alertness.

Motorists should be instructed in the inherent dangers due to inattention or because of idle curiosity when momentary stoppages occur. Courtesy among drivers will avoid much of the confusion that occurs at entrance and exit points. The selfish driver and the reckless driver should learn that consideration for others will make a safer highway for all.

In addition, traffic enforcement cannot be neglected on freeways. Traffic rules and regulations are established to benefit all motorists. Traffic police, in sufficient numbers, must be available to patrol urban freeways so that enforcement is uniform, consistent, and rigid. The patrols are particularly required near the entrances and exits in order that smooth movement of traffic will result at those locations, which in turn affects the movements on the rest of the freeway.

Thus, if entrances and exits are adequately located and designed, if motorists are alert and attentive, and if traffic regulations are enforced consistently and uniformly, there is reason to believe that urban freeways can be operated in a satisfactory and successful manner.

Ribbon Development in Australia

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RIBBON development, or roadside development as it is known in the United States, is one of the serious problems of urban growth. This has not always been the case. There have been tendencies for settlements of all sorts to grow up along routes of access, but only in recent years has the use of motor vehicles increased so greatly that roadside settlement has become evident as a major problem.

Motor vehicular traffic and ribbon development have become almost interdependent because commercial developers wish to locate where traffic is thickest, and because traffic is generated by commercial land uses.

The real problem lies in commercial development—in shops, hotels, theatres, undertaking parlors and the like—that increases both pedestrian and vehicular traffic on thoroughfares where they are situated. Such uses, increasing the difficulty, danger, and cost of traffic, may greatly reduce the ability of a road to carry traffic. Where ribbon development is extensive, its effects often justify the deviation or widening of a road or even the provision of an entirely new road. Before this point is reached, however, the usefulness and also the appearance of a road may be preserved by a limitation of the land use along its frontages.

In Sydney, the capital city of the state of New South Wales, this course of action is being followed. Measures to combat the increase of ribbon development have been brought into effect under the provisions of the Cumberland Plan—a regional planning scheme for the metropolitan area of Sydney and its country environs.

Metropolitan Sydney's population is nearly two millions and

covers an urban area of 670 square miles. The planning scheme embraces the County of Cumberland which contains Sydney and has a total area of 1,650 square miles. The County is made up of forty local government areas including small country shires, suburban municipalities and two city areas of Sydney and Parramatta. These local government areas are controlled by elected councils that elect representatives to the Cumberland County Council, the central local government authority responsible for the preparation and operation of the County of Cumberland Planning Scheme.

The County Council was established in 1946 and prepared the scheme that came into effect by Act of Parliament in 1951. Since then the council has been engaged primarily in the implementation of the scheme.

The Cumberland Plan

The scheme is a regional one, akin to a master plan, and it has in fact been so-called on many occasions. The problems that faced the council in drawing up the scheme were similar to those of many other cities. The central City of Sydney, the main centre of trade, commerce and employment, was beginning to suffer from traffic congestion; it was surrounded by a ring of once attractive but ageing residential areas rapidly declining through the intrusion of industry and traffic and a lack of redevelopment or reasonable maintenance.

Farther out, the suburbs were sprawling for miles without adequate schools and parks and shopping centres, and still farther out, the country areas were rapidly subdivided far in excess of requirements with consequent scattering of development and increasing burdens to local government bodies in the provision of unused or partly used works and services.

Linked with these defects was an increasing motor vehicle ownership and decreasing use of public transport.

The County Scheme aimed at solution of these problems in a pattern of development illustrated broadly in Figure 1.

Advantage was taken of the tendency to dispersal or decentralisation, just beginning, and a system of district centres or sub-cities in the outer suburbs was set out. These district centres were expected to provide concentrations of shops, offices and public buildings and industrial employment within easy reach of large suburban popu-

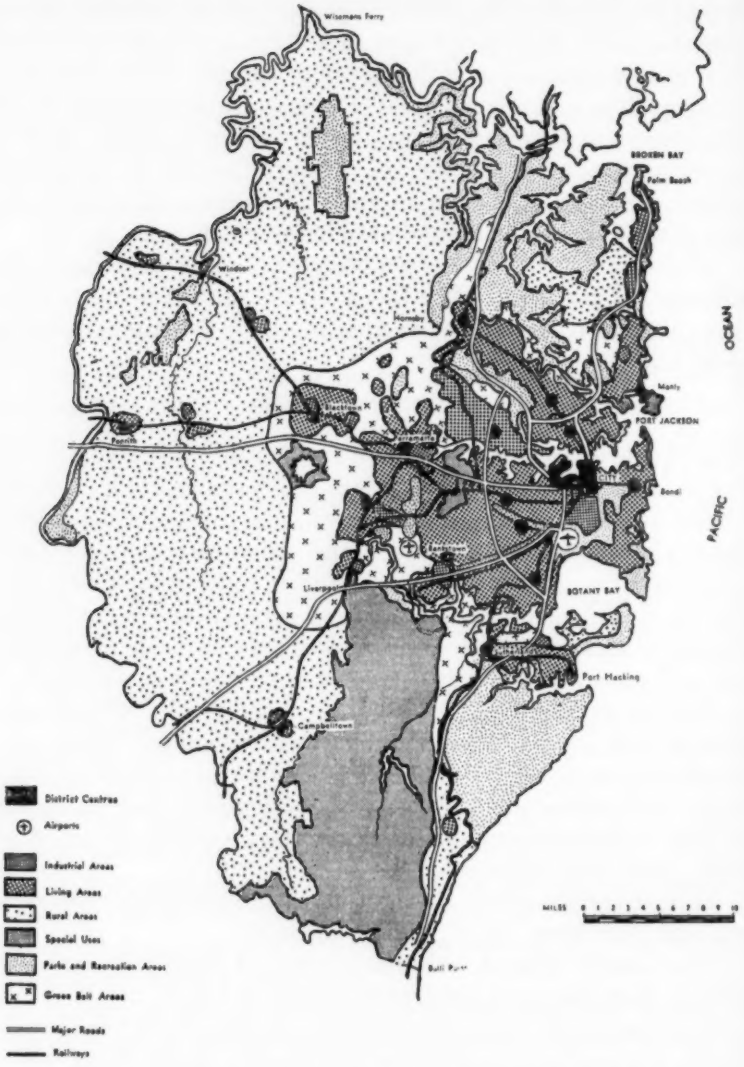

Figure 1. County of Cumberland Planning Scheme. Functional plan.

lations, shortening the journey to work and reducing the concentration of the metropolis on the central City of Sydney.

The constant outward spread of the metropolitan area was checked by a Green Belt, or permanent ring of countryside and national parks. One of the main purposes was to allow the economic provision of works and services and transport within a more compactly built-up urban area.

Inside the Green Belt, a pattern of land-use zones was determined providing for separation of incompatible land uses, yet allowing a variety of uses with planning approval. An example is the living area zone where shops, schools, and small service industries can be allowed, larger industries prohibited.

A system of metropolitan parks was also laid down, and outside the Green Belt, a rural area was zoned providing for agricultural use and for future overspill from the enclosed metropolitan area by the establishment of satellite towns.

Substantial advances have been made in the achievement of these objectives over the last seven years.

Threading the whole county with the varied functions of linking Sydney to the rest of the State of New South Wales, linking the district centres to each other and to the central city, a system of county roads was designed to serve circumferential traffic as well as radial. This road system contained 760 miles of road, 133 miles entirely new, and 627 miles being existing roads or widenings of existing roads.

The road system was also designed to overcome the problems of ribbon development. This solution reached its highest form in the eighty-eight miles of proposed expressways that will have no frontage development and from which local traffic of all kinds will be segregated.

However, the construction of this road system is still a long way in the future. Although the scheme has been in operation since 1951, only one small elevated section of expressway standard has been built. Rights-of-way have been protected and acquired in some cases. Improvements have been made to many surface streets by widening and with median strips, improved alignments and surfaces. Still the traffic problem is continually increasing. Everything that can be done must be done to maintain and increase if possible the capacity and safety of the existing road system.

Capacity and safety are determined not only by the geometrical standards but also by the extent of the mixing of through and local traffic. The prevention or control of ribbon development is an effective means of limiting the volume of local traffic entering a through-road or stopping or turning upon it. By this means the traffic-carrying capacities of existing roads can be conserved.

Legal Provisions of the Scheme

Under the legislation accompanying the scheme, known as the Ordinance, the responsibilities for administering the provisions of the scheme are shared by local councils and the county council. Broadly speaking, the *county* council is responsible for the things that are metropolitan or regional in character such as the Green Belt, large parks and recreation, and county roads; *local* councils are responsible for living and industrial areas, district and city centres, and rural areas.

In regard to the county roads, the county council has power to purchase vacant land and also to control development on the lands affected by the roads. The ordinance also provides for additional controls over lands adjacent to the roads.

Clause 47[1] provides for the governor of New South Wales to make proclamations restricting ribbon development. These proclamations can include restrictions in the following broad categories: 1. Prohibition of all or any particular classes of buildings within certain distances of the road; 2. control of means of access and egress, loading accommodation, passenger areas and fuelling space for all or any classes of buildings; 3. prohibition of permanent excavations, and 4. control of length of frontage in subdivisions.

These restrictions may be such as to prohibit development adjacent to the roads concerned. However, they have not yet been applied to any of the roads within the county area. A first-stage method of control in a simplified and more flexible manner is considered desirable.

This is possible under Clause 43[2] of the Ordinance. Under this clause, it is necessary for consultation to be carried on between local councils and the Cumberland County Council on all development

1 and 2, Appendix I, p. 49.

on frontages to county roads or main roads or on intersecting road frontages within 300 feet of these roads.

This requirement of consultation concerns approximately 700 miles of existing road and many thousands of individual properties. Consultation on every proposal would have involved both county council and local councils in a great deal of correspondence. At an early stage, it was concluded that this should be reduced as far as possible.

The reduction has been achieved by the county council's determining in advance an overall policy in regard to all road frontages and conveying this to local councils as an expression of its views. Before preparing the policy, the need for ribbon development control had been established by a series of investigations.

Effects of Ribbon Development

The effect of a building on traffic in adjoining roads depends on the factor of "traffic generation" of the building. The amount of traffic and its composition varies through wide limits depending on the size and purpose of the building. For example, a dwelling generates little pedestrian or vehicular traffic; a theatre concentrates a high volume of pedestrians at certain times, and a gas station attracts few pedestrians but many vehicles.

Under the ordinary conditions of frontage development, each building has its own pedestrian or vehicular entrance to the thoroughfare. In the case of the high traffic generators, the movement of traffic to and from an individual building may be as much or more than from an intersecting street.

Additional complication is caused by parking, loading, and unloading vehicles at the curb. A single parked vehicle is enough to reduce the capacity and increase the hazard.

Questionnaires supplemented by field counts established the relationship between traffic-generated and various classes of land use shown in Figure 2. There are wide variations within classes but a pattern can be seen clearly.

Keeping frontages clear of traffic-generating land use will obviously reduce the quantity of local traffic and allow greater freedom of movement for through-traffic.

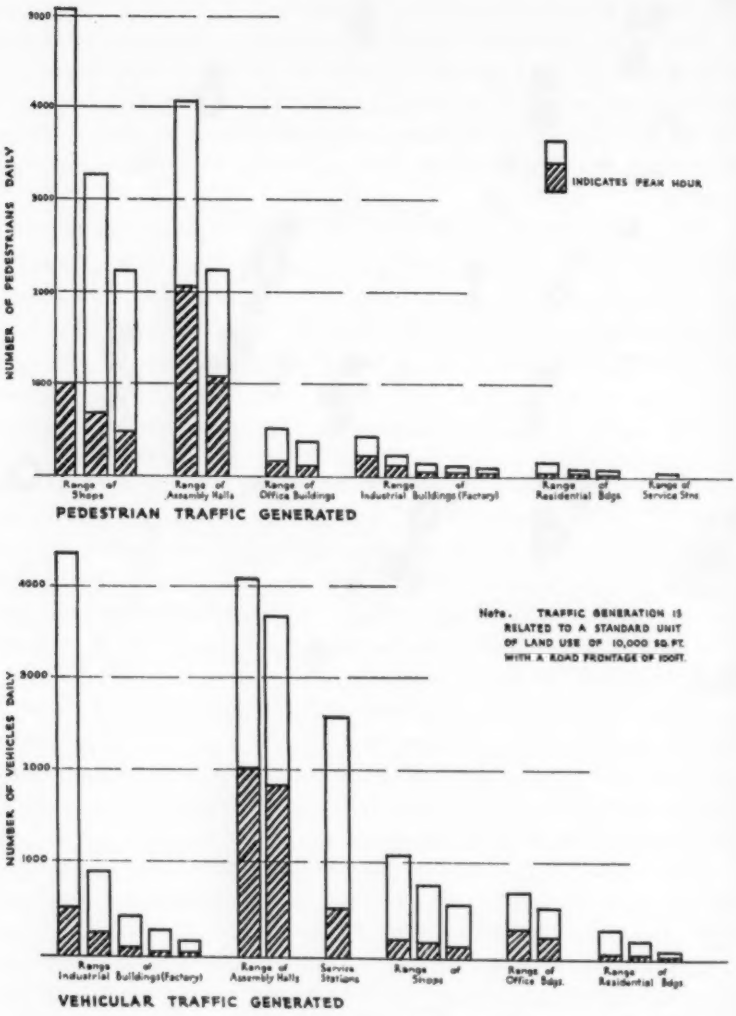
NUMBER OF PEDESTRIANS DAILY
INDICATES PEAK HOUR
Range of Shops
Range of Assembly Halls
Range of Office Buildings
Range of Industrial Buildings (Factory)
Range of Residential Bdgs.
Range of Service Stns.
PEDESTRIAN TRAFFIC GENERATED
NUMBER OF VEHICLES DAILY
Note. TRAFFIC GENERATION IS RELATED TO A STANDARD UNIT OF LAND USE OF 10,000 SQ. FT. WITH A ROAD FRONTAGE OF 100FT.
Range of Industrial Buildings (Factory)
Range of Assembly Halls
Service Stations
Range of Shops
Range of Office Bdgs.
Range of Residential Bdgs.
VEHICULAR TRAFFIC GENERATED

Figure 2. County of Cumberland Planning Scheme. Traffic generation, 1952.

A road's traffic-carrying capacity is determined by the width and alignment of the carriageway, the number and type of intersections, the extent of curb parking and loading, and the extent of interference by pedestrians crossing the road. It is generally accepted that capacity varies from more than 2,000 vehicles an hour per lane to 300 an hour and even less in congested streets where the speed of movement is sometimes reduced to two or three m.p.h.

Road Capacity

Generally speaking, however, where traffic flow is not unduly impeded, a centre lane on an urban road should be able to carry 1,200 vehicles an hour. The maximum capacity in Sydney's road system is reached on the Harbour Bridge, an expressway in character although the lanes are narrow and there is no physical separation of opposing traffic streams. The second and third lanes of this bridge carry up to 1,500 vehicles an hour per lane in the peak hour.

The situation where roads are affected by ribbon development is very different. Surveys have shown that on some of Sydney's most important roads such as Parramatta Road, Victoria Road, and Princes Highway, the traffic volumes in the more congested areas range from only 230 to 720 vehicles an hour per lane. Surveys of traffic flow have been carried out by the council and other authorities. These have all demonstrated the greater ability of roads to carry traffic when the frontages are free of traffic-generating development. A series of time delay surveys carried out in 1954 and 1955 along main trafficways showed a correlation between ribbon development and delays to traffic. An example of this is shown in Figure 3.

Road Safety

Safety on a road is determined largely by freedom of interference with the free flow of traffic. The factors that determine capacity also have their effect on safety.

During 1957, traffic accidents killed 359 persons and injured 9,518 in the County of Cumberland. Most of the accidents occurred on main roads, and again there was a definite correlation between accidents and ribbon development. An example is shown in Figure 4.

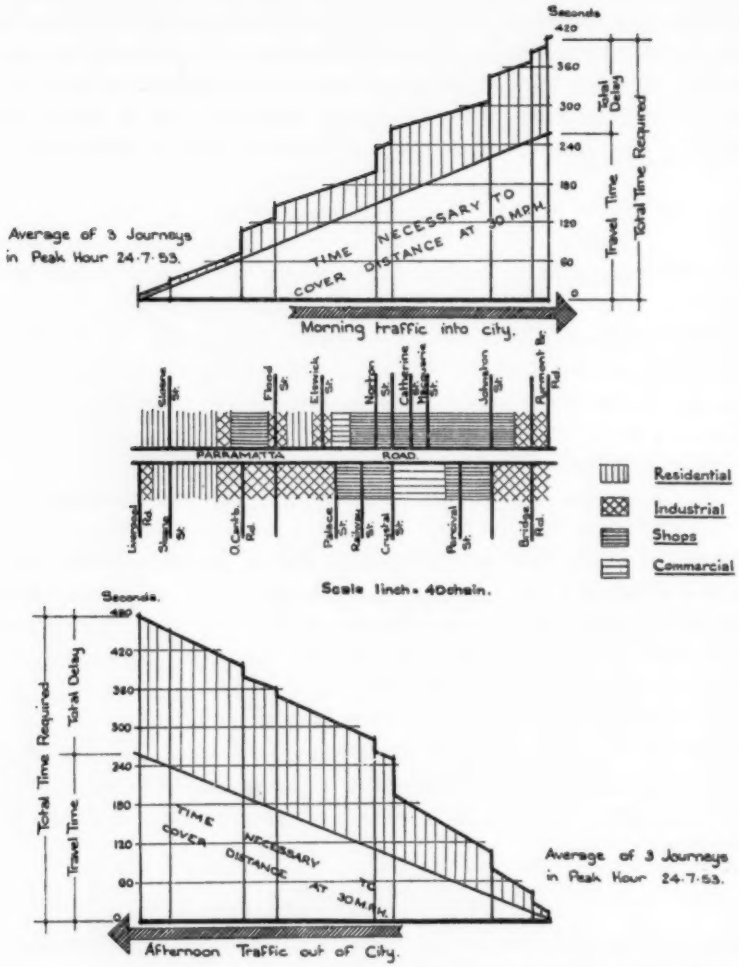

Figure 3. County of Cumberland Planning Scheme. Land use and traffic delay. Parramatta Road, 1953.

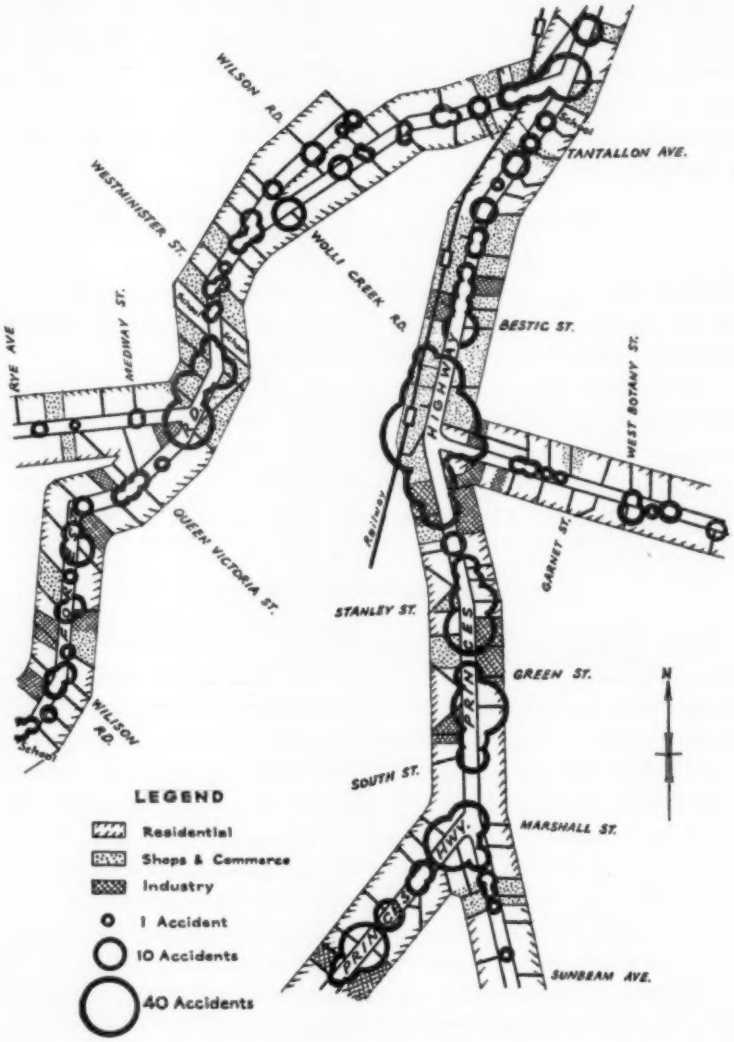

Figure 4. County of Cumberland Planning Scheme. Ribbon development and road accidents, 1946–1951.

The complication of traffic movement caused by particular types of land use with resultant traffic dangers is illustrated in Figure 5. These show counts at typical service stations and illustrate the problem of right-turning traffic which occurs even when service stations selling the same brands of petrol are located opposite each other. Similar situations of varying intensity occur with other traffic-generating land uses.

Increased Costs of Travel

Ribbon development means delays in traffic movement that lead to increased running costs. This has been shown conclusively by research in the U.S.A. and Great Britain.

An additional item that can be considered in the cost of travel is the loss through accidents. This is tangible enough as far as damage to vehicles is concerned; what is not so clear is the loss to the commu. nity through the injury or death of accident victims. Reduction of accidents through improvement in traffic conditions will reduce these losses.

Valuations and Appearance

Ribbon development invariably means a mixture of many land uses designed and built separately and having no uniformity of architecture and appearance. It is accompanied by increased quantities of posts and poles and overhead wires, a variety of traffic signs and signals and advertising signs and hoardings. While no one of these things may be wholly objectionable in itself, the conglomeration can be one of the most unsightly products of this age.

The limitation of this indiscriminate development would be a great advantage as far as roadside appearance is concerned.

The onset of ribbon development is usually marked by increases in values of adjoining property and up to a point these will probably be substantial. It may also induce obsolescence as property owners allow buildings to deteriorate in anticipation of high profits for another use. However, when the commercial development or whatever it may be has reached its peak, or traffic congestion has worsened sufficiently, values may start to fall, particularly near the extremities of the development.

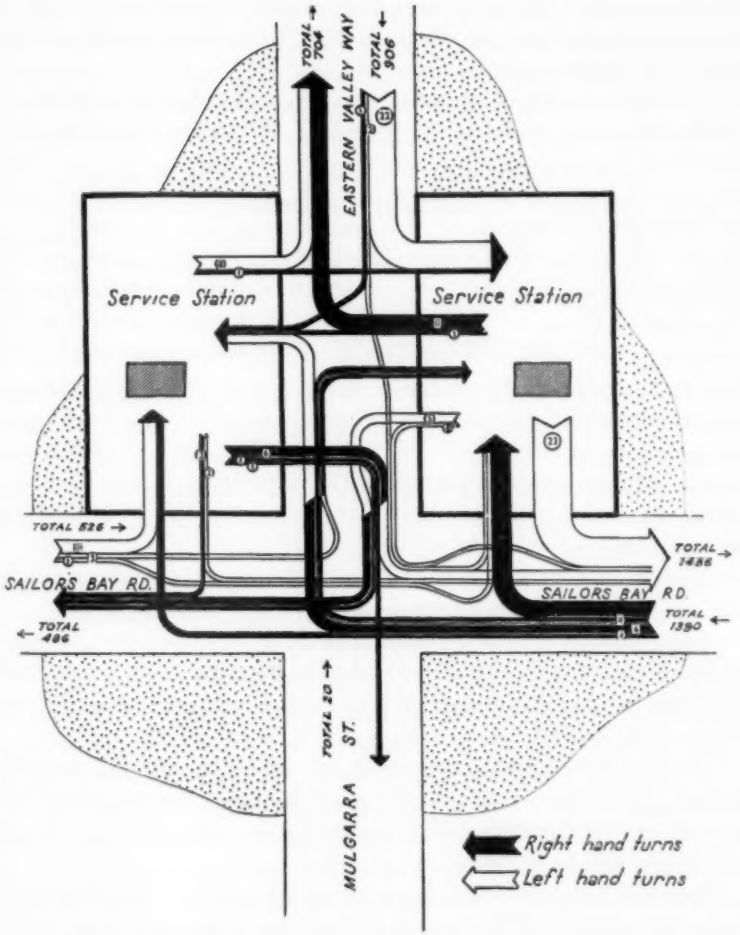

Figure 5. County of Cumberland Planning Scheme. Vehicular movements at 2 service stations 8:40 A.M. to 12:15 P.M. Saturday.

Individual commercial buildings may also have an adverse effect. An all-night service station is not a desirable neighbor in a residential area, nor is a hotel with insufficient off-street parking where customers' cars may stand in front of dwellings within a radius of several hundred yards.

The preservation of the character of a neighborhood is an important factor in justifying the control of ribbon development.

Principles of Control

Clearly the capacity and safety of roads and the appearance of the roadsides can be protected by the restriction of ribbon development. The controls formulated aim at minimising the extent of ribbon development and also at restricting land use to that generating the least amounts of traffic, so far as this is practicable in the circumstances of the particular locality. The controls also aim at preserving the good appearance of roadsides and to this end the erection of signs and hoardings is restricted wherever possible. Under the legislation, these things are structures and planning approval must be obtained for their erection.

The proposals defined after close examination of land use on the road frontages provide for three broad classes of control.

The primary aim is the preservation of roads where frontages are free of commercial development. In these cases, it is intended that land use should be restricted to the low volume traffic generators such as residences.

At the other extreme are the roads which are already heavily built up with commercial development. In these cases consolidation by way of additional buildings in character with the existing development will be allowed.

Between these two extremes are a number of road frontages where the existing development is a mixture of low and high traffic generators. In these cases each individual application must be dealt with on its merits. This provides some flexibility in the operation of controls but as time goes on it may be possible to become more precise and transfer some of these road frontages to the other classes.

Definition of these three classes has enabled the county council to advise local councils of its views for all road frontages thus re-

ducing the need for individual consultation on development applications to the third or intermediate class.

In addition to the overall land-use control provided by this classification, additional controls may be desirable in respect to site dimensions and layout, building lines, and access and parking. Land uses requiring these supplementary controls are factories, service stations, drive-in theatres, roadside stalls and other similar activities. The council has already adopted policies concerning some of these and it is intended that further policies will be defined as time goes on. Summaries of policies already adopted and in operation are contained in Appendix 2.

Operation of Controls

The proposals have been put into effect by maps defining the three classes of control. The maps are mainly at a scale of four chains to the inch with some at larger scales in inner suburban areas and smaller scales in the country. A total of 850 maps is required to cover the County of Cumberland.

The controls in operation since September 1957 have proved satisfactory. Much new ribbon development has been prevented and although some applicants have taken their cases to court, the decisions of council have been upheld.

The most recent case before the court concerned an oil company's application to construct a service station in a section of road frontage where council considered development should be restricted to residential uses.

The application was refused by the local council. This was in conformity with the Cumberland County Council's opinion, but the oil company exercised its right of appeal to the Land and Valuation Court. The Cumberland County Council then gave evidence in support of the local council.

Two grounds were advanced in opposition to the service station. One was that a service station would be out of keeping with a residential neighborhood. The second related to the control of ribbon development and the traffic difficulties that would be created by the service station, these being greater than would be the case if development were residential only.

In the judgment, an extract of which is quoted in Appendix 3, considerable weight was given to these two grounds and the case was decided in favor of the local council.

This judgment has considerably strengthened the ribbon development controls and has created a precedent of legal argument that will be valuable in any new cases of a similar nature.

Conclusion

The control of ribbon development by the means previously discussed has so far proved reasonably satisfactory, but its success rests on full enforcement and the co-operation of the local councils. The Cumberland County Council has offered its technical assistance to local councils and in the successful case referred to earlier much of the evidence against the proposal was given by officers of the county council.

However, there are costs involved in legal procedure and for this reason alone some local councils may hesitate before refusing an application for development which may result in an appeal to the Land and Valuation Court.

The necessity of controlling ribbon development must be constantly emphasised and if this is not sufficient to induce satisfactory control consideration will have to be given to the making of proclamations under Clause 47. The county council will then be charged with the functions of carrying into effect and enforcing the provisions of the proclamations. This would still be done in consultation with the local councils but the county council would be the final authority.

Although it has not yet been necessary to make any proclamations this may be the next step in the control of roadside development in this country.

APPENDIX 1

Provisions of the County of Cumberland Planning Scheme Ordinance Relating to Ribbon Development Control

CLAUSE 47

(1) The provisions of this clause shall apply to any county road or to any main road within the meaning of the Main Roads Acts, 1924–1950, or to any part of a county road or main road to which road or part such provisions are applied by the Governor by proclamation.

(2) The Governor, in respect of any land fronting, adjoining or adjacent to a road to which the provisions of this clause apply, may by proclamation—

(a) prohibit the erection of buildings or any specified class of buildings or buildings intended for use for specified purposes within such distance of the road as may be set out in the proclamation;

(b) direct that, in respect of the erection of buildings or any specified class of buildings or buildings intended for use for specified purposes within such distance of the road as may be set out in the proclamation, unless the responsible authority is satisfied that either—

(i) the character of the building or the use to which the building is to be put is such as not to be likely to cause traffic congestion on the road; or

(ii) satisfactory arrangements have been made for limiting traffic congestion on the road;

the responsible authority shall as a condition of its consent to the erection of any such building require the provision and maintenance of such means of entrance and egress and of such accommodation for the loading or unloading or parking of vehicles or picking up and setting down of passengers or the fuelling of vehicles as may be determined by the responsible authority for the purpose of limiting such congestion;

(c) prohibit the making of any permanent excavation within such distance of the road as may be set out in the proclamation;

(d) prohibit the subdivision of any land which provides for the creation of separate parcels of land with a length of frontage to the road less than that specified in the proclamation.

For the purposes of this subclause "building" has the meaning ascribed to it in paragraph (b) of subsection three of section 342D of the Act.

(3) Any proclamation made under subclause (2) of this clause—

(a) may apply generally to all buildings or particularly to any specified class of buildings or buildings intended for use for specified purposes;

(b) may specify different distances for different buildings or for different classes of buildings or buildings intended for use for different purposes or different distances for different roads or different distances for different parts of the same road.

(4) Any such proclamation may be amended, varied or revoked by a similar proclamation.

(5) A proclamation made under this clause shall be published in the Gazette and in a newspaper circulating in the locality in which the road is situated.

A copy of any such proclamation shall be served on the responsible authority and on the council of the area in which the road is situated.

NOTE: In respect of the provisions of this Clause, i.e. the restriction of ribbon development, the Cumberland County Council shall be the responsible authority and shall be charged with the function of carrying into effect and enforcing such provisions.

CLAUSE 43

(1) The responsible authority before determining any application made to it under this Ordinance for consent to carry out the following development of land, that is to say:—

(a) all development within a Foreshore Scenic Protection Area;

(b) all development within a Waterfront Industrial Area Zone;

(c) the following development not being development within the Business and Commercial Centre (County) Zone—

(i) all development, except residential development, on land having frontage to a main or county road; or

(ii) all development, except residential development, on land having frontage to a road connecting with a main road or county road which frontage is wholly or partly within three hundred (300) feet, measured along the road alignment of such connecting road, of such main road or county road;

(iii) hotels, transport, terminals, drive-in theatres, bulk terminals, television and broadcasting transmitters and relay stations, heliports, aerodromes and airports;

(iv) the erection of any building or group of buildings to be used wholly or partly as commercial premises where the total floor space in such building or group of buildings exceeds 20,000 square feet.

(v) the erection of any building or group of buildings to be used wholly or partly as a shop where the total floor space in such building or group of buildings exceeds 15,000 square feet;

shall consult with the Cumberland County Council and shall take into consideration any representations made by that Council in relation to the proposed development: Provided that where the application relates to development, referred to in subparagraphs (i) or (ii) of paragraph (c) of this subclause, of land which is within a Rural Area Zone the responsible authority shall not consent to the development without the concurrence of the Cumberland County Council.

(2) Where the Cumberland County Council is the responsible authority it shall before determining any such application consult with the council and shall take into consideration any representations made by the council in relation thereto.

(3) The responsible authority before determining any application made to it under this Ordinance relating to land of the Crown shall consult with the Minister in relation to such application.

APPENDIX 2

Summaries of Policies on Roadside Development

1. DRIVE-IN THEATRES

The two main factors in consideration of drive-in theatres are:—

(a) the traffic generated and the requirements for handling this both at the theatre and on the approach roads.

(b) the effect of the theatre and its traffic on surrounding areas by dust, noise, lights and appearance.

The principles of the policy have been laid down to ensure effective means of handling traffic and to minimise the adverse effects of the theatre on its surroundings.

The principles are as follows:—

(a) no entrance or exit direct to major (County or Main) roads.

(b) entrance or exit to be not less than two chains from the intersection of a minor road with a major road.

(c) adequate planting on boundaries of site.

(d) fencing to be unobtrusive.

(e) regard to be had to the appearance of buildings.

In addition the Ordinance prohibits drive-in theatres in Living Areas, and the Theatres and Films Commission has regulations requiring a holding area for vehicles

awaiting a second session equivalent to the theatre capacity and fixing the distance of the ticket office from the public road.

These restrictions have been put into effect and found satisfactory.

2. CARAVAN PARKS

Caravan or "trailer" parks are becoming more numerous.

Under the provisions of the Ordinance they can be located in all zones including Living Areas and as they are nearly always adjacent to a major road special safeguards on site treatment and appearance are necessary.

The principles laid down are as follows:—

(a) *Location.*

Sites adjoining main highways or tourist and holiday centres are desirable—subject to certain safeguards.

(b) *Access Provisions.*

(i) Entrances and exits should be separated.

(ii) They should be twenty-five feet wide, splayed out at forty-five degrees towards carriageway. Axis at right angle to road, maximum grade 10 percent. If adjoining a main road, location of entrances and exits should allow for—

(iii) clear visibility over a distance of 200 feet in both directions;

(iv) a minimum distance of 300 feet from an intersection with another main road or from traffic lights;

(v) a minimum distance of 100 feet from any other intersection.

(c) *Drive-in Area or Forecourt.*

If adjoining a main road, an area of 5,000 square feet should be provided outside the enclosure of the park with a minimum width or depth of fifty feet.

(d) *Set-backs.*

Minimum distances from property boundaries to caravans, laundries, ablution blocks, and toilets.

	Desirable	*Minimum (where adequately screened)*
From a public road or reserve	150 ft.	50 ft.
From an adjoining property	50 ft.	25 ft.

(e) *Restrictions as to Land Use.*

Only normal functions associated with a tourist establishment, as defined in Clause 24 of the Scheme Ordinance, should be permitted. Maximum period of stay should be limited, and registration of vehicles and occupants provided for.

(f) *Internal Layout.*

The size of stall occupied by one caravan and towing vehicle should be standardised at thirty feet by forty feet. (Each stall to have frontage to an internal access road.)

(g) *Appearance.*

A high standard of design and construction of all buildings, establishment and care of ground cultivation, the preservation of existing trees, additional planting and the protection of other landscape features should be encouraged.

(h) *Advertising.*

(i) Limited to signs relating to the business of the establishment;

(ii) Only two signs should be placed along a road frontage, one facing in each direction;

(iii) Area of each sign to be restricted to sixty square feet;

(iv) Illumination of signs shall not create glare in relation to on-coming traffic; intermittent lighting should not be used.

3. SERVICE STATIONS

Service or "gas" stations have greatly increased in number in recent years. In 1952 there was an average of one for every 135 vehicles in Australia: Prior to World War II most stations were of the kerbside variety and served a variety of petrols. About 1952 the oil companies began to develop single brand stations and coupled with rapidly increasing vehicle ownership this resulted in rapid growth of stations often with three or four rival companies establishing in a neighborhood previously served by a single station.

It was realised that some controls on location, site layout and appearance were necessary and most of the oil companies have also realised this and have co-operated.

The principles laid down are as follows:—

(a) Service stations need to be located on major roads but the ideal site should be on a straight section clear of intersections and with good visibility.

(b) Service stations should not be located at points of traffic congestion or where complicated traffic movement already exists as at a major intersection.

(c) All stations should provide for adequate drive-in space and parking for at least six vehicles and all servicing should be conducted off the thoroughfare.

(d) Sites should have frontages of not less than 100 feet; petrol pumps should be set back at least fourteen feet and buildings at least thirty-four feet.

(e) Driveway widths should be at least twenty-seven feet with radii of not less than thirty feet and be not less than sixty-six feet from a minor intersection.

(f) Stations must have a reasonable architectural standard and a simple uncluttered appearance. Courts should be paved and some planting is preferred. Advertising should be reduced to a minimum.

APPENDIX 3

The Land & Valuation Court, Sydney, 28th April, 1958—Extract from Judgment
The Shell Company of Australia Ltd. v. Ryde Municipal Council

"In relation to proposed developments fronting main and county roads, responsible authorities are entitled, and may be obliged, under the amended ordinance, to consider the matter more widely than in its purely local aspects or as an isolated development. It is now permissible, and it may be necessary to view the proposed development and its effects in their relationship to a planned road system for the county, and, so viewing them, to consider them in the light of the overall plan and of long-term plans and prospects, and not merely as a local matter or one involving a consideration only of present facts and the foreseeable immediate future.

"Taken by itself, and viewed only in relation to the presently existing circumstances, a service station on this site might well turn out to be at most a minor impediment only to traffic flow in Blaxland Road, more particularly when there is weighed in the balance the advantage of added visibility of traffic approaching from North Road because of the open space which would remain in front of the proposed service station building. I should mention here, too, that the appellant has offered to make land available to round off the corner and provide for the canalisation of the traffic from the two roads, and also to contribute to the cost of the necessary works.

"However, it is necessary to take into account certain further considerations. First, that as the widening of the carriageway proceeds, the concrete carriageway at this point will ultimately have four traffic lanes extending over the full kerb to kerb width of the road. Secondly, the traffic load on Blaxland Road is likely to increase considerably. And thirdly, that Blaxland Road is to become an important link in the circumferential road system.

"It is also necessary to bear in mind that what is aimed at by the Cumberland County

Council is that, so far as possible, the traffic in Blaxland Road, as such a link, should be free along the entire course of the road from any avoidable impediment or distraction irrespective of its magnitude in individual cases. The attainment of complete immunity from any uncontrolled access whatever being impracticable, the purpose of the Cumberland County Council's representations appears to be a control of roadside development such as will ensure the minimum of interference with the flow of traffic which, as a practical matter, can be attained. It may be that a service station, if of adequate area, is from this point of view less objectionable than such forms of commercial development as lead to the parking of vehicles at the kerbside. However, its effect has been appropriately likened in evidence to that of the junction of a minor side road with the county road—in the present case to a side road with a traffic flow of, perhaps, 150 vehicles per day in each direction, that is, from and to the county road.

"The evidence is that there are about eleven service stations within half a mile or thereabouts of the subject land. Proceeding south along Blaxland Road from near Balaclava Road to the Top Ryde shopping centre there are four service stations on the same side as the subject land (three before reaching it and one about a quarter of a mile further on) and one service station on the opposite side. Few only of those which I have mentioned have driveways for vehicles awaiting service which would be adequate by modern standards. The two closest to the subject land are respectively about a quarter of a mile to the north on the opposite side of Blaxland Road and about a quarter of a mile to the south on the same side. Neither of these two has adequate driveways at present, but the latter is undergoing substantial enlargement. These deficiencies have been brought out in evidence on behalf of the appellant, but, although it is likely that the proposed new station would attract some of the business now done by existing stations in Blaxland Road, there appears to be no ground for believing that it would have the effect of eliminating such existing service stations as have inadequate driveways.

"Although the views expressed on behalf of the Cumberland County Council are not conclusive upon the Court, weight should be attached to its considered opinion on a question of general planning principle in an area which is peculiarly its concern. It is apparent from the evidence that the question of ribbon development and its effect upon the flow of traffic along county roads has been much considered by that Council and that the views presented to the Court have been arrived at after full consideration. It is also apparent that, although all of the relevant provisions have not as yet been implemented, the legislature has itself treated the fast and safe movement of traffic on county roads as a matter of public interest to be advanced under the County of Cumberland Planning Scheme and has made provision for control of development fronting such roads and of access thereto as a mode of advancing that public interest, and that the Cumberland County Council should be the responsible authority—see Clauses 5 (f), 43 (1) (c) and proviso and (2), and 45–47.

"This being the nature of the Cumberland County Council's objection, it does not meet it to say that the individual effect of a particular development taken by itself would, or might, be inconsiderable. The objection appears to be founded, rather, upon the multiplication, and stringing out along the course of a road of new points of access and departure for substantial numbers of vehicles. Each such point then has a tendency to slow down traffic either because of the actual movements of vehicles from and to the county road or because of caution dictated by the apprehension that such movement may occur. As I have said, the Legislature has itself made provision for dealing with these questions of access to county roads and ribbon development along them in what might, in its application, be a more absolute manner—see, e.g., Clauses 46 (3), (4) and (5), 47 (2). These provisions have not yet been brought into effect by proclamation. But one may gather from them the purposes which they are intended to serve, and it would appear that the Cumberland County Council seeks to achieve, so far as is practicable, substantially the same objects through the exercise by responsible authorities of their extended discretion under Clause 27

coupled with their duty under Clause 43 to consult with the Cumberland County Council and consider its representations.

"This appeal resolves itself into two main questions: first, the erection of a service station in the virtually exclusively residential area north-west of the junction of the two roads, and, secondly, the through flow of traffic. Although separately raised, these are not completely independent matters since the second also raises the question of retaining the residential character of this section of Blaxland Road. As to both matters there is now no question of the extent of discretionary power under the Ordinance. The first is a question of local amenity involving selection or allocation amongst the various classes of development which are permissible, or permissible with consent, in a living area zone, under the wider discretionary power now conferred upon responsible authorities even in the absence of a local planning scheme. The second is a similar question of selection or allocation with the difference that the public interest envisaged is not a local interest but a more general interest in relation to county roads, invoked, in this case, not by the respondent Council of its own motion but as a result of representations made by the Cumberland County Council.

"Both are questions of opinion or planning policy in respect of which, in the absence of some sufficient ground based on public interest or in the circumstances of the case, the Court does not, in general, interfere with the decision of a responsible authority which reflects a proper understanding of its own powers and duties and of the circumstances of the matter for consideration and is actuated solely by the Ordinance—see Mitchel v. Sydney City Council (2 L.G.R.A. 152 at pp. 158–159). The matters relied upon here have already been adverted to and do not, in my opinion, furnish sufficient reason for setting aside the respondent Council's decision. I am therefore of opinion that the appeal should be dismissed.

"The order of the Court will be that the appeal be dismissed with costs."

The Pittsburgh Transportation and Traffic Program

MICHAEL J. GITTENS

Mr. Gittens is Traffic Engineer for the City of Pittsburgh, Pennsylvania. For six years he had charge of the Bureau of Traffic Planning, and was Traffic Engineer for Allegheny County for one year. Previously, Mr. Gittens had fourteen years' experience in traffic and transportation with the Pittsburgh Railways Company in Pittsburgh. He is a Registered Professional Engineer in Pennsylvania, and a director of the Institute of Traffic Engineers.

As early as 1941, residents of the Pittsburgh area recognized that serious traffic problems were developing. The first 160-mile section of the Pennsylvania Turnpike, extending from Carlisle in the center of the state to Irwin in the west, was opened to public travel on October 1, 1940. The Turnpike, from that date to the present, has been the principal route for east-west travel in Pennsylvania.

Until the sixty-seven-mile link between Irwin and the Ohio state line was opened on August 7, 1951, eleven years later, motorists on Routes 22 and 30, two of the principal U. S. highways between the Midwest and the Northeastern states, passed through the city of Pittsburgh. In the Golden Triangle, which is the central business district, both highway routes followed the Boulevard of the Allies, a six-lane internal city street.

Traffic counts in 1941 show that the Boulevard of the Allies carried 41,800 vehicles in both directions on an average day. The daily volume decreased to 32,200 in 1947 as a result of World War II influences, but increased to 37,400 in 1953 and to 44,000 vehicles daily in 1955. The increase took place even though the Pennsylvania Turnpike at that time carried 12,000 vehicles per day, by-passing the City of Pittsburgh.

In 1941, the Penn-Lincoln Parkway was a dream of the few who realized that a limited-access freeway was needed to accommodate the growing traffic volumes. The Parkway takes its name from U. S.

Route 22, the William Penn Highway and U. S. Route 30, the Lincoln Highway. It will carry these routes from about ten miles east of Pittsburgh to ten miles west, passing through the central business district on a narrow strip of land at the edge of the Monongahela River and bordering the internal street system.

For these twenty miles of highway the total cost has been estimated at 150 million dollars. Much of the cost is for numerous and varied structures required by the rugged topography, intensive land use, waterway requirements, and traffic needs of the central Pittsburgh area. For the last twelve years, erection of these structures has been proceeding at an ever-increasing rate. Outstanding examples are the $1,800,000 Commercial Street Bridge, the 4,200-foot Squirrel Hill Tunnel, the Fort Pitt Bridge carrying four lanes of traffic in each direction at different levels, and the Fort Pitt Tunnel. A three-mile section east of the Triangle and including structures for the Downtown Interchange, the Gateway Interchange, and the Fort Pitt Bridge, will cost approximately fifty million dollars.

At the confluence of the Monongahela and Allegheny Rivers, there are two bridges—the Point Bridge spanning the Monongahela and the Manchester Bridge spanning the Allegheny. Constructed in 1926 and 1914, respectively, these bridges were located too close to the actual confluence of the rivers to permit proper interchange of the traffic that they induce. Accordingly, new structures—the Fort Pitt Bridge and the Fort Duquesne Bridge—are being built approximately 1,000 feet up the respective rivers from the Point to allow room for a workable traffic interchange. This arrangement accomplishes another purpose in that a considerable area of land is freed of roadways and buildings, for developing the Point State Park to perpetuate the historical significance of the Gateway to the West.

Traffic going to and from the new bridges or passing around the Point area will funnel across the Gateway Portal. This structure consists of parallel roadways having a minimum width of seventy feet between curbs in each direction with weaving sections approximately 230 feet long.

The last section of the parkway east will be completed and opened to traffic early in 1959; the Fort Pitt Bridge will carry traffic on at least one level before the fall of 1959; both levels of the

Figure 1. The Brady Street Interchange on the Penn-Lincoln Parkway with ramps connecting the Parkway to the Boulevard of the Allies.

Figure 2. The Golden Triangle showing the Gateway Interchange, Penn-Lincoln Parkway, two new bridges, and the Point State Park, Pittsburgh, Pennsylvania.

Figure 3. The Greater Pittsburgh Airport is the second largest in the United States.

Figure 4. The proposed Auditorium in the Lower Hill Redevelopment area will have approximately 1,700 parking spaces.

bridge and the Fort Pitt Tunnel will be in full operation by 1960. The motorist will then need less than thirty minutes to traverse twenty miles of what was once a chaos of traffic-clogged routes and tortuous congestion.

Parkway Leads to Airport

The western terminus of the parkway connects with U. S. Routes 22 and 30 by an interchange approximately five miles from the Greater Pittsburgh Airport, the second largest airport in the country. A divided highway, constructed by the County of Allegheny, extends the free-flowing characteristics of the parkway to the airport. An airline passenger will have available a highway facility that will bring him within twenty minutes' travel time of the business district.

Construction of the parkway, originally a part of the primary state highway system, was undertaken by the Pennsylvania Department of Highways with the co-operation of Allegheny County and the City of Pittsburgh before consideration was given to the federal aid highway act. As a result, sections of the highway were opened to traffic before the parkway was designated as part of the interstate system. Credit is given to the Allegheny Conference on Community Development and the Pittsburgh Regional Planning Association for co-ordinating planning efforts and obtaining citizen support.

The parkway comprises a large part of the two and one-half billion dollar redevelopment program that has attracted world-wide attention and set a pattern for the rest of the nation.

The major portion of the Penn-Lincoln Parkway, some sixteen miles long, is now part of the vitally important National System of Interstate and Defense Highways. This section alone comprises one-fifth of the eighty miles of interstate system allocated to the Pittsburgh area. Most of the parkway designated as interstate highway was completed, paid for, and in use prior to the Interstate Act. Only the most recent construction contracts were financed with federal aid (90–10). At the present time, 75,000 inbound and outbound trips are made daily on both the east and west sections.

The Pennsylvania Turnpike, built as a toll facility, constitutes another significant share of the designated interstate mileage in the Pittsburgh area. Twenty-six miles of the Turnpike, passing through

the metropolitan area, together with sixteen miles of the Penn-Lincoln Parkway total forty-two miles of the interstate system—more than half of the eighty miles allocated to this area. Thus, half of the interstate mileage, with allowance for work that is being completed, has already been built with other than interstate funds, and is now in use.

The interstate system mileage also includes interstate Route 34, yet to be built from Pittsburgh to a point of connection with the interstate highway which will be constructed between Washington, Pennsylvania and the Pennsylvania Turnpike at Warrendale. Completion of the interstate system will solve some of the worst problems, but will leave many troublesome areas where traffic congestion will occur. The objectives of the interstate system will not have fulfilled the needs of an industrial area that ranks third in the nation behind New York and Chicago.

The greatest need of the whole district is a crosstown boulevard at the base of Pittsburgh's Golden Triangle. Most of the studies for the boulevard have been made, and final plans completed on certain portions. Work can begin immediately.

A request to designate the Crosstown Boulevard as part of the interstate system was not immediately approved, but there is some hope that the request will be granted later when the remaining interstate mileage is allocated.

The request involved the addition of two miles of highway. To avoid undue delay, the first section of the Crosstown Boulevard will be constructed early in 1959, receiving federal aid as part of the urban primary highway system.

The Pittsburgh area received fewer interstate system miles than did many other cities of smaller population, smaller square mileage, and less industrial importance. The following table gives pertinent information with respect to the area and the allocation of interstate mileage:

Population:	City of Pittsburgh	683,000
	Metropolitan area	2,335,000
Productive steel capacity:		
	Within 30 miles of Pittsburgh	26,084,820 tons
	Within 30 miles of Chicago	22,955,200 tons

Pittsburgh area manufacturers: 2,401 with 305,015 employees
Interstate Mileage Allocations:[1]

Pittsburgh	80[2]	Indianapolis	110
Boston	85	Kansas City	110
Houston	85	St. Louis	110
Baltimore	90	Atlanta	115
Cleveland	90	Chicago	115
Detroit	105	St. Paul-Minneapolis	120
Columbus	110	Washington	130

The solution of Pittsburgh's traffic problems challenges the traffic engineer and the highway design engineer. Steep hills, deep ravines, and wide rivers required the construction of 1,500 bridges in Allegheny County, 148 of them in the city itself. Pittsburgh is frequently called "the most bridged city in the world." The central business district occupies approximately .5 square mile, of which .175 square mile is street space.

Six hundred thousand people are funneled in and out of this area every working day. More than half of them—310,000—ride private vehicles. Forty to fifty percent of the trips have destinations beyond the Golden Triangle. Adequate highway facilities in the form of an inner belt system (of which Crosstown Boulevard is the important connecting link) will keep much of this traffic out of downtown streets.

A highway study made by the Allegheny Conference on Community Development (May 1957) estimates that there will be more than 600,000 motor vehicle registrations in Allegheny County by 1967, an increase of more than 100,000 over the present figure.

New Projects Planned

Co-operation of the various planning agencies, highway departments, public works agencies, and local authorities enabled the area to solve many traffic problems. Recognizing that all of the problems have not been removed, the various agencies continue to plan new

1. Covers a 400 square-mile area for each city, generally ten miles in each direction from the hub of the major city. Source: General Location of National System of Interstate Highways, U.S. Dept. of Commerce, Bureau of Public Roads.

2. Forty miles have been constructed with other than interstate funds, and are now in service.

projects. In the spring election of 1958, the Board of County Commissioners asked the people of Allegheny County to approve bond fund expenditures for the building of a new nine million dollar Glenwood Bridge, a new ten million dollar Sixty-second Street Bridge, and a six and one-half million dollar grade separation at the north end of the Liberty Tunnels. All of these projects will provide improved access to major highway facilities. The voters approved the necessary appropriations, and construction plans are well under way. These facilities will remove bottlenecks where large volumes of traffic pass from city streets to grade-separated roadways.

The Pennsylvania Department of Highways is completing studies for important highway improvements, some of which are on the interstate system and some on the urban primary system. These studies include an extension for the Penn-Lincoln Parkway East; completion of Crosstown Boulevard including a new bridge across the Allegheny River; replacement of congested Route 51 skirting the Triangle on the south side of the Monongahela River with a controlled access freeway; location of Interstate 34 in the North Side area of the city; location of an expressway connecting Pittsburgh with Erie, and location of the interstate highway between Washington, Pennsylvania and Warrendale, Pennsylvania.

The City of Pittsburgh, working with the Urban Redevelopment Authority, developed a new and vastly improved street pattern in the Gateway Center, where three new office buildings were constructed by the Equitable Life Assurance Society. A fourth office building and an underground parking garage are presently under construction. The Bell Telephone Company, the Hilton Hotels Corporation, and the State of Pennsylvania selected building sites in Gateway Center, joining many large companies who elected to enjoy the atmosphere of the redeveloped area.

The new street pattern eliminated many points of traffic conflict created by short blocks and an irregular street pattern. The traffic generated by the redevelopment project will move smoothly and swiftly from the Triangle by ramps connecting directly with the parkway and the new bridges. Similar adjustments in out-moded street systems are being made in the Lower Hill Redevelopment area where a new auditorium is taking shape, and in the East Liberty and North Side sections of the city.

During the construction and redevelopment period, many challenges have been encountered. The programming of new projects and the arranging of construction schedules in separate phases require constant co-ordination. Co-ordinating committees made up of developers, consulting engineers, highway officials, utility companies, traffic police and traffic planners, have been most helpful. In each area where a new project is undertaken, a separate committee is appointed even though a new committee may resemble one of its predecessors.

By bringing the designer, the contractor, and the traffic planner together early in the planning stage, it is possible to co-ordinate work schedules in a way that will minimize inconvenience to the public. At times, existing street capacities have been cut to a minimum—an unexpected blockade at the wrong time would have been very serious. Occasionally, re-routing signs were changed on a week-to-week basis. It was recognized that some inconveniences had to be tolerated to obtain the benefits of new facilities.

Two-Year Study Will Cost $1,000,000

As previously indicated, much progress has been made. The urgent need for improved traffic facilities made it imperative that relief be provided for the most critical problems. The worst conditions were easily recognized. Studies of individual regions proceeded as required, but difficulty was experienced in attempting to relate the problems of any one area with those of the neighboring communities. The need for a master plan including all of Allegheny County became apparent.

In June 1956, the Pennsylvania Department of Highways proposed that an origin-and-destination study be made of Allegheny County. After considering this proposal, the city and county made a joint request for a comprehensive transportation study, to include inventories of vehicular trips, transportation systems, mass transportation trips, street capacities, and land use, together with analyses of economic trends, census trends, and future growth. The study was started in the Spring of 1957 and a report will be prepared within two years. The data obtained will form the basis for a master plan of highways and mass transportation.

The cost of the study is estimated at one million dollars, with fifty percent being provided by the Bureau of Public Roads and the remainder by the State of Pennsylvania, the County of Allegheny and the City of Pittsburgh. Consideration is being given to annual up-dating of the report so that current information will be available to the participating agencies at all times. A policy committee made up of four members, one representing each of the governmental agencies, directs the operation of the study and promotes harmony.

Vehicular movements into the Golden Triangle have been increasing constantly, partly because of trips generated by new modern buildings in the redevelopment area and partly because people are deserting mass transportation. Either or both reasons bring about the need for additional storage facilities in or close to the downtown district.

Pittsburgh was one of the leading cities to build and promote use of off-street parking garages. To date, the Pittsburgh Parking Authority has constructed six garages and one lot. Two additional garages, including the Gateway underground garage, are under construction, and plans are underway for acquiring land and installing parking lots in most of the secondary business districts. The new Auditorium, being built on the fringe of the Golden Triangle, will have 1,700 parking spaces, many of which will be available for all-day parking, particularly when the building is scheduled for evening events. A proposed stadium site, located across the Allegheny River from the Triangle, will have capacity for 10,000 to 12,000 vehicles; most of these spaces will be available for all-day parking since evening and week-end events are most attractive to sports fans. Walking distances from the auditorium and stadium lots to the business district are not excessive, and mass transportation is conveniently available.

Mass Transportation a Serious Problem

Increasing use of private vehicles creates fear that Pittsburgh's mass transportation system, consisting of a conglomeration of seventeen separate operating companies, will decline to a point where revenue will not adequately support the individual companies, and the public will become completely dissatisfied with the service that the fares

will support. The mass transportation problem becomes more critical each year because of decreasing revenues, fewer passengers, higher fares, and loss of patronage attributed to work stoppages during labor contract negotiations.

The local transportation system consists of one large company, operating street cars and buses, and sixteen smaller bus companies. Each bus company operates from one to ten routes, using various streets in the downtown district and in many cases requiring separate stops. There are also seventeen intrastate long-distance lines that terminate in or pass through the central business district. Public Utility Commission restrictions result in many dead miles of operating revenue on streets where one company is permitted to pick up and discharge passengers but competitors operate with closed doors.

Of all the streets in the downtown district, only two minor streets do not carry mass transportation vehicles. Most transit routes loop in the downtown district, leaving the area on the same streets or parallel streets, and add a large number of trip miles that might be eliminated by combining lines that enter from opposite sides of the Triangle.

The 1957 state legislature considered a bill that would have combined the transit lines in Allegheny County, but failed to act favorably on it. Provisions of the bill have been restudied by the Allegheny County Mass Transportation Study Committee, and a redraft is being made ready for presentation to the next meeting of the legislature in 1959. The bill provides for the establishment of an authority with power to acquire, operate, and manage a unified system, and to establish fares, construct new facilities and plan for future development. The bill gives consideration to subways, monorail, private right-of-way, and fringe parking lots. The continued life of mass transportation in this area depends upon unification, and this can best be accomplished under the powers granted to an authority, since private enterprise has not indicated sufficient interest.

The Pittsburgh Railways Company operates the largest fleet of electric street cars in the United States, and has long term franchises that enable the company to continue the present plan of operation. On many important traffic arteries, two-way street car operation is

maintained. The decision to retain or alter the present layout of routes or to substitute buses for street cars rests with the Railways Company according to the terms of franchises that constitute legal and binding contracts on the part of the city and the company. The street-car equipment is in good condition, represents a large investment, and ranges in age from eleven years to twenty-two years.

Some satisfaction is obtained from the fact that only buses have been purchased during the last ten years. A slow trend in the replacement of street cars with buses is developing. Where new highway or bridge construction takes place, the Railways Company frequently finds that economies result from the substitution of buses for street-cars; the cost of track replacement, together with paving costs and overhead wire installations, is excessive, compared with bus replacement. Each decision must give consideration to revenue per mile and frequency of operation.

The traffic engineer is interested in the elimination of street cars, because the fixed track vehicle does not permit any flexibility in his planning of street use. Attempts to change streets from two-way to one-way operation have been resisted by the Railways Company. An important consideration, although not always the strongest argument, is the track and overhead lines costs resulting from adjustments in route locations. Significant improvements in the circulation of traffic in the downtown district are foreseen when the last street-car trip is made.

Pittsburgh's progress, comprehensive in scope, includes extensive urban redevelopment, without which other gains would have been insignificant. It includes a highway program, designed to meet current needs and projected for future growth and development; it also includes efficient use of existing facilities to obtain maximum use of all available means of meeting the transportation problem. Every attempt is being made to balance storage space for vehicles with highway capacity; effective use of mass transportation with growing use of the private vehicle; and freedom of movement into and out of the Golden Triangle with a high level of commercial activity in the central business district.

New Approach Needed to Finance Metropolitan Transportation

LENNOX L. MOAK

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ONE of the primary jobs of local government today is the development and maintenance of regional transportation systems that will facilitate commerce, promote personal convenience and encourage safe and economical movement of people.

Major attention to the need for inter-state roads and for part of the urban system has been afforded by the new federal highway program. Federal and state governments are generally in a good position to finance their respective obligations under the federal-state programs. The capacity of local governments to finance their portions of the inter-state program and at the same time provide almost single-handedly for strictly local systems requires much broader attention than has thus far been given.

While the nation may be able to afford the luxury of three competing, non-integrated systems of basic intercity transportation (rail, highway, and air), cities and metropolitan areas cannot. The years between now and 1975 are crucial ones for cities. With many elements of local economy in a status of extreme flux today, the challenge to local government is at its peak.[1]

If local government within each metropolitan area can act in reasonable concert, it may still have a significant influence upon

1. In this paper, the term "local government" is intended to embrace the municipal and other governmental units comprising a metropolitan area, unless the term is specifically used in a different context.

the pattern of community organization. If, however, the doctrine of *laissez-faire* coupled with unreasoning prejudices and unreasonable jealousies within the region is permitted to run its full course, the outcome will not be in the total public good. Not only will destructive competition probably result between different portions of the same community, but also patterns that enable one community to function as an "economic city" while another sinks to the level of an "uneconomic city." The latter will find it increasingly difficult to attract or even to retain industry and related activities so necessary to a sound economic base.

Management for expanding national corporations, whether by growth or by the merger route, tends to become more and more absentee in character. Its decisions as to location, expansion, contraction, and abandonment are dictated by the corporation's capacity to function profitably.

Confronted with the rising competition within and between metropolitan areas, confronted also with the need of facilities and financing, metropolitan areas wishing to survive as viable units of economic and social life, have a tremendously tough problem of both policy and administration to meet, and meet successfully.

Purposes for Which Money is Required

Local governments in most metropolitan areas of 1900 were directly concerned with performance and financing of only one local transportation function, provision of local streets. A few were concerned with mass transit requirements, but this concern was largely awarding and supervising franchises for private transit companies. There was no need for local expressways, off-street parking facilities or traffic control systems.

In a brief six decades, almost all metropolitan communities have found it necessary to concern themselves directly as principals in not only the local street system, but also in local expressways and traffic control systems. Few have escaped the necessity of active concern in some form with rapid transit, and even fewer from participation in the search for a solution to the parking problem.

The emphasis upon capital needs in these fields has frequently obscured the importance of the problem of maintenance of capital

facilities and, in the case of traffic control and rapid transit, large operating costs.

It is no longer possible to avoid genuine concern over the magnitude of financing all elements of regional transportation requirements. Moreover, the present plight of the railroads indicates that some heroic efforts will be required to sustain commuter services which the railroads have heretofore underwritten for most of the very large metropolitan areas.

Inadequate information is available concerning the magnitude of total requirements for regional transportation systems. Studies of major metropolitan areas, including New York, Chicago, Philadelphia, and San Francisco, show that it far transcends anything to which we are accustomed. An entire new focus is required.

To relate the needed requirements to something more tangible, it is appropriate to point out that Philadelphia's Urban Traffic and Transportation Board Program, published in 1955, calls for capital expenses of more than $1,500 million over a period of twenty years. In 1955, the total revenue of the core city of Philadelphia for all municipal purposes (excluding schools) amounted to $166 million. Total revenues for local municipal services (likewise excluding schools) for the entire five-county area in southeastern Pennsylvania centering on Philadelphia amounted to only $218 million.

Thus, that area would be confronted with capital needs that approximate thirty-five percent of total annual local revenue if spread over two decades. Moreover, these estimates in Philadelphia did not include huge maintenance and operating costs for facilities to be constructed. Nor did they include large sums necessary for several aspects of the local road system, for transit subsidies, and the like.

While the state and federal governments will absorb part of the cost through the federal-state road systems, the bulk must still be financed.

Somewhat similar problems are confronted by many other local governments.

Present Sources of Revenue

The financing of metropolitan-area transportation systems represents a hodgepodge of local, state, and federal participation.

At the state level, taxation for the road system has been largely upon motor vehicle users, and rightly so. For several decades the federal government has participated in the cost of much of the state road system and recently this participation has been increased markedly. This federal money once came from general taxation but now is derived largely, if not exclusively, from motor-user taxes.

For decades, many state highway departments stopped at the corporate limits and left to municipalities the financing of the portion of the state-federal system that lay within corporate boundaries. More recently, the trend has been for full participation by state and federal governments in construction and maintenance within corporate limits; and the 1956 federal program markedly expands the amount of state-federal participation, particularly upon some of the new urban roads.

The local transportation system, exclusive of the state-federal and state systems, within the metropolitan areas (and particularly at the core) has been financed largely from local funds.

A few decades ago, almost all street improvements were financed from assessments upon abutting property or a combination of assessments and general local revenue. Gradually, as use of the road system lost its purely neighborhood character, some elements of the system were taken over by the city from general revenue. The WPA, the depression, and higher costs accelerated this process. Local government revenues continued until about 1940 to accrue exclusively from the property tax with a few minor supplementations here and there. By the end of the 1930's local governments had secured some grants-in-aid from state governments, and had been allowed flexibility in some states by the imposition of new sources of taxation—primarily sales and income.

Today, street system financing at time of construction is a combination of assessments, capitalization as a part of new developments, and general local revenue. Road maintenance and operation costs are met from local taxation coupled with state-grants-in-aid.

Traffic control systems, both mechanical and by police, tend to be financed almost wholly from general local revenue.

The pattern of off-street parking varies widely, both within and between metropolitan areas. Some areas have gone a long way toward public ownership by local government. Generally, the privately-owned, off-street parking facilities have been fully dependent

upon user charges and have paid their way fully, including ad valorem taxes. Publicly-owned parking facilities have normally depended upon user charges for amortization of capital and operating expense, but generally have not been required to make payments in lieu of taxes. In a few municipalities, the public parking ventures are providing handsome profits.

Local expressways have in a few instances been financed from tolls, notably in the New York City area. The tendency appears to depend upon general local revenue supplemented by state and state-federal sources.

The revenue system for local transit, whether ordinary or rapid, continues to rest primarily upon user fees. But changing patterns of need and use have brought both political and economic forces into play. There is a tendency for transit to secure subsidy from tax sources to stay in operation. A notable exception to the method of general tax subsidy is the New Orleans experience where the surface-transportation deficit is regularly absorbed by the users of gas and electricity, inasmuch as these utilities are provided by the same private corporation that provides transportation service.

Bridges and tunnels have been widely accepted as a special service to be paid for by tolls from users. The tolls sometimes produce more revenue than is required for the facility financing and the surplus is available for other purposes.

Commuter railroad services were and continue to be financed by a combination of user charges and more recently by large subsidies from freight users of the railroads. New methods will be required if these essential links in our transportation system are to be kept in operation.

Admittedly, this summary of revenue systems represents a hodge-podge and, in most instances, constitutes little more than political opportunism. Certainly, the "system" in effect has not evolved from carefully constructed financing plans that took into account the practical effects of the means of financing. The point is clear: A new approach to the problem is required.

Some of the Elements of Solution

If the transportation system is to serve the best interests of the community, it must not only facilitate movement of goods and people

but must also represent a careful balance between the *benefit* and the *impact* of the revenue system upon the region's total economy.

It is foolhardy to develop a perfect transportation system only to find that charges necessary to finance it place the community in such a disadvantageous tax position that it is destined for the sheriff's sale.

Nor can the problem of financing be solved without also solving some basic legal and political-administrative problems.

It may be trite to restate the obvious, but it is necessary. Any effort to solve metropolitan transportation problems on a segmental basis—functionally, politically, or geographically—is doomed to ultimate failure. Therefore, the first rational step is to determine in as great depth as possible the nature of the need. This should be stated in terms of physical facilities. Reliable unit costs should be developed. The components of the program should be priced.

Given the fact that political-administrative considerations may require the adoption of alternatives, a reasonable number of alternatives should be explored. These should also be priced. Upon the basis of the best judgment available, the practical cost-ranges of desirable programs should then be stated.

At this point some excruciating examination should take place in terms of realistic cost-benefit studies. The hue induced by rose-colored glasses should give way to stark realism. This is no place for sentiment. The future well-being of the community may well hinge upon the outcome. If the program calls for commitment of resources greater than those likely to be available, defeat is the ultimate answer—unless one wants to embrace the federalization of local government. Many would rise to reject such an alternative not only because it is a departure from time-honored formulas in American political institutions but because of the problems of popular control that would be imposed.

The present decade has brought to the fore many regional transportation studies. Some of these have been initiated and carried to conclusion by the core city with little or no participation by the remainder of the region. Other studies, such as that in the Chicago area, have been on the basis of joint participation by federal, state, and local governments. Still others have been conducted on an essentially fragmental basis by interested "authorities," as in the New York and Philadelphia areas. Where total studies with broad par-

ticipation cannot be achieved, these more limited ones are helpful but may result in wholly inadequate and ill-balanced end-products.

To repeat, this author believes that the next step is for each of our metropolitan areas to conduct comprehensive studies of all land transportation. Where feasible, this should also include the water-borne and air-borne transportation patterns and requirements. Again, such studies should embrace the entire cost-benefit analysis.

For example, in Philadelphia today, a new expressway is being built along the Delaware River from a point a few miles below Trenton to South Philadelphia. In the path of the expressway is a considerable amount of industrial development, some of which must be disturbed. Freeing some of these corporations' frozen assets is viewed by them as a "heaven-sent" opportunity to make a move from the core city. While these businesses may be retained in the region, the economic impact of the expressway has not been fully evaluated nor have all possible steps been taken to alleviate the adverse economic effect of introducing this new expressway.

Development of Regional Transportation Agencies

The metropolitan problem is a highly undefined concept. Clearly, however, for many metropolitan areas, the transportation aspect of this problem is of the highest priority. Its pressure has in some instances prompted the creation of a special purpose agency—usually of the authority type.

Careful students of government in its broader context are concerned over the tendency toward a proliferation of uni-functional, authority-type mechanisms. Thus in 1955 Philadelphia's Urban Traffic and Transportation Board urged the creation of a regional transportation agency but in doing so it endorsed the concept of an agency that could be subsequently assigned other functions when the community deemed this action desirable.

The creation of such regional transportation agencies is fraught with many practical difficulties. These are real and significant for metropolitan areas wholly within a single state and therefore within the constitutional and legislative action of that state. For those many metropolitan areas that spread to two or even three states, the legal and political problems become much more acute.

Even so, it is suggested that the important elements of popular

control must be preserved if the regional transportation agency is to be broadly accepted and to continue full responsibility and responsiveness to the constituency.

Practical Revenue Systems

The regional transportation studies thus far developed have usually been weakest in their recommendations concerning practical revenue systems. Obviously, if a regional agency is to function to maximum effectiveness, it must have the right to assess user charges and, where necessary, taxes. It may be obliged to operate one element of the system on a loss basis insofar as the narrow concepts of accounting are concerned. However, within the broader concept of profit and loss to the community, this kind of operation should not necessarily be abandoned.

The highly subsidized surface public transportation system in New Orleans has enabled that city to continue for more than thirty-five years with a seven-cent fare and unlimited transfers between routes. Results of that action have been in large measure responsible for retaining a higher degree of ridership and therefore have reduced the necessity for much more expensive alternatives.

The revenue policy of a regional transportation system will involve not only local user charges and local taxes but also assistance from state and federal governments. Some of this assistance will be nothing more than returning to the metropolitan areas that portion of motor-user revenues generated in such areas today but systematically syphoned off to ease the problems of less populous areas. Some of the assistance which may be required for the future may have to come from other forms of state and federal subsidies, perhaps primarily in connection with general urban renewal programs.

As pointed out earlier, the present system is a hodgepodge. It is beyond the purview of this article to suggest the precise adjustments that are desirable and equitable; however, those who would construct a rational and viable revenue structure for a metropolitan transportation system must be willing to challenge all of the present practices and precepts. Sound ones should obviously be retained; those that were sound a few decades ago but are no longer sound should with equal obviousness be rejected and discarded. This is a

tough job. It requires sound technical analysis; it requires sound judgment; it requires a new soundness in political arenas.

Competent Management and Manpower

No inconsiderable portion of our present problems arises from incompetent management—management that is not only incompetent but without imagination and, most important, without courage. Generally we have paid too little for management to attract and retain the kind of men we require.

Beyond the matter of management is the matter of competent technical personnel. While competent consulting assistance, if properly used, is a tremendous asset, there remains the continuing problem at the technical level. The consultant, unless he is an employee in the guise of consultant to escape salary and residence requirements, is necessarily a bird of passage. He makes his contribution and moves on. Good technical and operating personnel are required to evaluate consultant findings in the light of local conditions and to carry through those consultant recommendations deemed appropriate for adoption.

Public transportation systems in all metropolitan areas are multi-million dollar undertakings; in some they are multi-billion dollar undertakings. Beyond this, decisions made by management on basic features of the transportation plan will, to a degree not generally recognized, control the tomorrow of metropolitan areas.

Can we afford to entrust such fundamental decisions and their execution to mediocre people? Few would contest the statement that the importance is all but overwhelming—yet presidents and sales managers of numerous less important functions are regularly paid salaries that make those accorded top jobs in the regional transportation field look paltry indeed.

In summary, the requirements are: An analysis of need; a regional transportation agency; practical revenue systems; careful cost-benefit analysis; competent management, and competent manpower.

Increasing City Street Capacity

W. R. BELLIS

Mr. Bellis' experience is based on thirty-one years with the New Jersey State Highway Department where he is Chief of the Traffic Design and Research Section. He served as Highway Traffic Engineer with the United States Army in Europe during World War II. He was graduated from Rutgers University in 1926 with a B.S. degree in Civil Engineering.

STREETS are the land-service roadways that make it possible to use adjacent land areas. The purpose for which the adjacent land area is used dictates to a large degree the behavior of traffic on the street. In some areas, children use the street for a playground; in other areas, pedestrians' activity is so intense that they occupy the entire roadway as well as the sidewalk area.

In many areas, half—often more than half—of the street is used to park vehicles. In some cases, business is carried on within the roadway; and in many cases the business carried on adjacent to but outside of the roadway, necessitates the street-use solely to serve this business activity.

Generally, a network of streets form a grid pattern with streets intersecting at grade. A typical city street provides from two to four lanes of moving traffic. Once they are provided, their location and width are permanently established. Practically all will remain so for hundreds of years—yes, thousands of years. And we shall always have pedestrians as well as automobiles.

Congestion

Congestion on our city streets is a problem that seems hopeless to overcome; and so it is, unless we can change our concept of city-planning. Far too many people live, work, and perform other activities within too small an area. When we consider the transportation of individuals today in their normal activities, we should include the automobile as part of that individual similar to a turtle in its shell.

People traveling around in a car occupy twenty times as much area as they require on foot. Our population has doubled in fifty years and with the change from foot travel to travel by automobile the area we occupy has increased forty times. Some of our cities, considered overcrowded fifty years ago, have not increased in area.

Because of intense congestion, decentralization has been taking place and will continue until there is a balance between the desire to live close together and the desire for freedom of movement. It will be years before this balance is reached. Many unforeseen problems will arise because as yet we do not know what this balance should be.

Statements are made that we should preserve our cities. Why? To protect the investments already made in the cities? Statements are made that our population is increasing so fast that we are becoming overcrowded. A trip by air over our most densely populated states will prove this to be false. Yes, our cities are overcrowded but our country is not. The present population of the United States could live in Texas and have three acres per family of three.

A municipality (New Brunswick, New Jersey) has a population of 38,811 (1950 Census), an area of 3,520 acres and a high degree of congestion. Another municipality (Pennington, New Jersey) has a population of 1,682 (1950 Census), an area of 634 acres and practically no congestion. The first has a population density of 11.03 persons an acre and the second has a population density of 2.65 persons an acre. Somewhere between these two is the maximum number per acre without congestion. For the sake of this illustration, it is assumed that if there were no more than four persons an acre, there would be no congestion.

If the total 1950 population of New York state, including New York City, were dispersed into one-eighth of the area of New York state there would be four persons per acre—or no congestion. Or, the population of New York City and the population of New Jersey dispersed in New Jersey would be less than four persons per acre—or no congestion.

In New Jersey, 1,361,950 people live in municipalities with a population density of *less* than four per acre (1950 Census), and 4,835,329 people live in municipalities having four or *more* per acre. One half of the population lives in densities above 9.83 and the other

half below 9.83 persons an acre. The most densely populated municipality is West New York, Hudson County, with 65.42 persons an acre.

This analysis suggests the analysis of all municipalities and areas in search of the maximum population density per acre to produce no congestion. Of course there are factors other than population to be included.

In 1890, there was serious congestion in New York City with horse-drawn vehicles. The population in 1950 was three times the 1890 population. Traffic engineers have continually attempted to solve the congestion problem, but congestion has continually become worse.

This discussion is not in the spirit of hopelessness. It is an effort to illustrate the magnitude of the problem from the traffic viewpoint so that city-planning may consider the possibility of planning future cities to fit the automobile.

Generally, the demand on traffic engineers is to increase the capacity of city streets without altering the streets. Nearly every recommendation of the traffic engineer receives strong objection and usually is not acceptable to the city. Recently, cities are prohibiting on-street parking, developing off-street parking, but only to a small percentage of the demand.

Prohibition of on-street parking is fully effective in providing additional lanes only when bus stops and other stops are also prohibited. Traffic will not use the right-hand lane effectively if there is the possibility that a vehicle ahead may stop. To provide sufficient off-street parking in business districts, more than fifty percent of the buildings should be demolished and the structure height drastically limited. It might be argued that this would injure the existing business, but if this is not done, fringe-area shopping centers will continue until central areas will degenerate anyway.

A progressive step is to tear down all the buildings along every alternate street. That is, assuming the streets are numbered 1, 2, 3, etc., to tear down all the buildings on the even numbered streets and use the area for parking, with the odd numbered streets used for moving traffic only.

This type of reconstruction can be economically sound where the desired areas for parking are relatively inexpensive to acquire and demolish.

In spite of the fact that decentralization is continuing, our city street problem will be with us for a long time.

Possible Source of Increased Capacity

The major source for increasing capacity of city streets without widening the streets is traffic signal control at intersections.

For even distribution of green time allotted to each of two cross streets, the capacity increases as the length of the signal cycle is increased up to a maximum at a ten-minute cycle. The design capacity of a ninety-second cycle is two and eight-tenths times as much as that for a forty-second cycle and the absolute capacity of a ninety-second cycle one and four-tenths that for a forty-second cycle.

By cycle length is meant the sum of one green, amber, and red sequence or the time from the beginning of one green phase to the beginning of the next green phase.

The design capacity (satisfactory capacity) is the maximum hourly volume during which no cars would have to wait for more than one red phase. This occurs when only one green phase during the hour is fully loaded.

The absolute capacity is the hourly volume during which all green phases are loaded. This occurs when traffic is backed up for a long distance and drivers must approach the intersection at slow wave-like speed variations during many changes of the traffic signal before reaching the intersection and proceeding through.

The design capacity of a 120-second cycle evenly distributed is one and two-tenths times that for a ninety-second cycle and the absolute capacity for a 120-second cycle is one and one-tenth times that for a ninety-second cycle. Many of our cities use forty-second cycles and many use sixty-second cycles. For even distribution of signal time there is little gain in capacity as the cycle is increased above 120 seconds. Another source of possible increase in capacity is the best possible synchronization of traffic signals for the conditions. Others are the prohibition of left turns at certain locations and the use of one-way streets at certain locations.

When left turns are prohibited and left-turn traffic must rotate around a block making three right turns, additional vehicle miles are created to arrive at the same destination. This results in higher traffic volumes on the streets involved. For a grid system of six

streets crossing six streets with equal volumes of traffic on each street and equal turning volumes the prohibition of all left turns causes almost fifty percent increase in traffic volumes on each street section compared to the system without left-turn prohibitions. This increase in traffic may cause more serious congestion than the left turns.

For the same grid system used as a one-way street system there would be a thirty-five percent increase in traffic volumes on each street section for the same origin and destination trips. It is obvious from this finding that left-turn prohibitions and one-way street systems, if used promiscuously as a general cure, can cause more harm than the benefit intended.

There are untested methods of controlling traffic that might prove successful in increasing capacity slightly but not enough to satisfy the need for twenty years hence, probably double the present.

Synchronization of traffic signals has been recognized as a desirable principle. Some systems use simultaneous synchronization and others use a progressive system. The capacity is the same in either case. A good progressive system is more desirable than a simultaneous system because it requires fewer stops with less time required to reach a destination. Nevertheless, it is difficult to obtain a good progressive system because necessary signalized intersections seldom are at the desired intervals. In such cases a perfect progression in one direction produces the least average travel time for the total two-way traffic. Also it can be shown that for some signal spacings a long signal cycle produces less travel time than a short cycle.

Elements of Capacity

The capacity of a lane of traffic can be assumed to be a large volume limited by conditions of area, roadway design, driver behavior, and vehicle. If a roadway had no physical restrictions, and if vehicles were chained rigidly together behind one another, the capacity could be infinite if the speed were infinity. This is not practical because each vehicle is controlled by an individual producing capacity limits dependent on the driver's ability to cope with existing conditions.

The largest lane-capacity known to have been experienced is 2,437 cars in one hour. Let us assume that a larger volume could be

obtained such as 3,700 cars an hour a lane shown in "Elements of Capacity Diagram." Elements limiting capacity to a volume less than 3,700 are listed at the left of the diagram. Each of these impeding elements reduces the capacity by a degree peculiar and

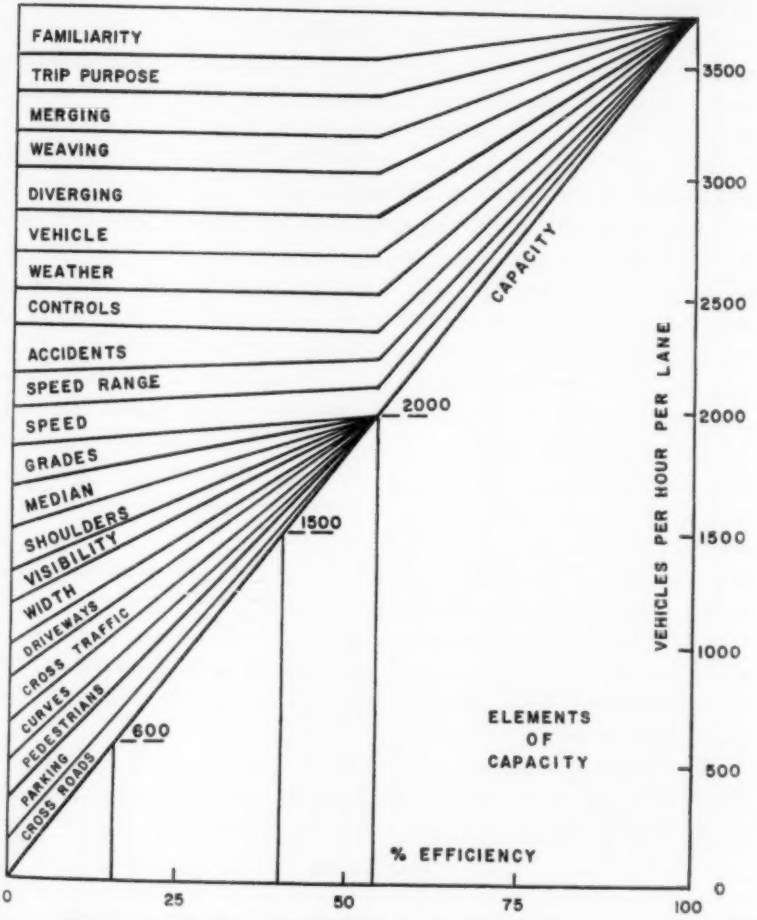

Figure 1. Elements that limit lane-capacity on city streets.

variable depending on the element. Most of these elements have not been isolated so that their effect can be measured. A few *have* been measured and, in the case of freeways, the combined influence

of a group of impeding factors can be measured since these factors have been eliminated.

The effect of some elements can vary from zero to 100 percent. Some such elements are pedestrians and weather. When any one element reduces the capacity by 100 percent (or more), the effect of the other elements is meaningless. In the diagram, capacity is shown as varying from zero to 3,700. A capacity is shown at 600 to represent city streets but some streets have less and some have more, depending on the effect of the impeding elements.

Some years ago, the capacity one city obtained from streets in one section of the city was 163 cars an hour. The capacity of state highways is plotted at 1,500 but the capacity of some state highways is no greater than the capacity of some city streets. The capacity of freeways is plotted at 2,000 but the capacity of some state highways may be as great as some freeways. From the diagram showing the hourly volumes on a summer Sunday for a location on a state highway the capacity could be taken as 3,000 cars an hour but the diagram showing a Tuesday morning in the fall shows that the section of highway carried 4,366 cars an hour. The only apparent difference is either in trip-purpose or familiarity or both. These impeding elements therefore had enough influence on Sunday to reduce the capacity by 1,366 cars an hour or 455 for the average lane of three lanes. This smaller capacity on Sunday than during commuter hours has been noticed elsewhere.

In the transition from city streets to freeway, a reduction of about 1,400 cars an hour a lane has been made in the influence of delaying factors, most of which results from eliminating eleven of twenty-two impeding elements.

Assuming that much has been done to reach the maximum efficiency of city streets, is it possible to find additional sources of increased capacity?

Crossroads

The hindrance classified as crossroads reduces the capacity of a lane because this lane must be unused while the crossroad lanes are used through the intersection area. Maximum efficiency is obtained when left turns and right turns are prohibited, when traffic signals are on a long cycle, and when signal progression along each cross-

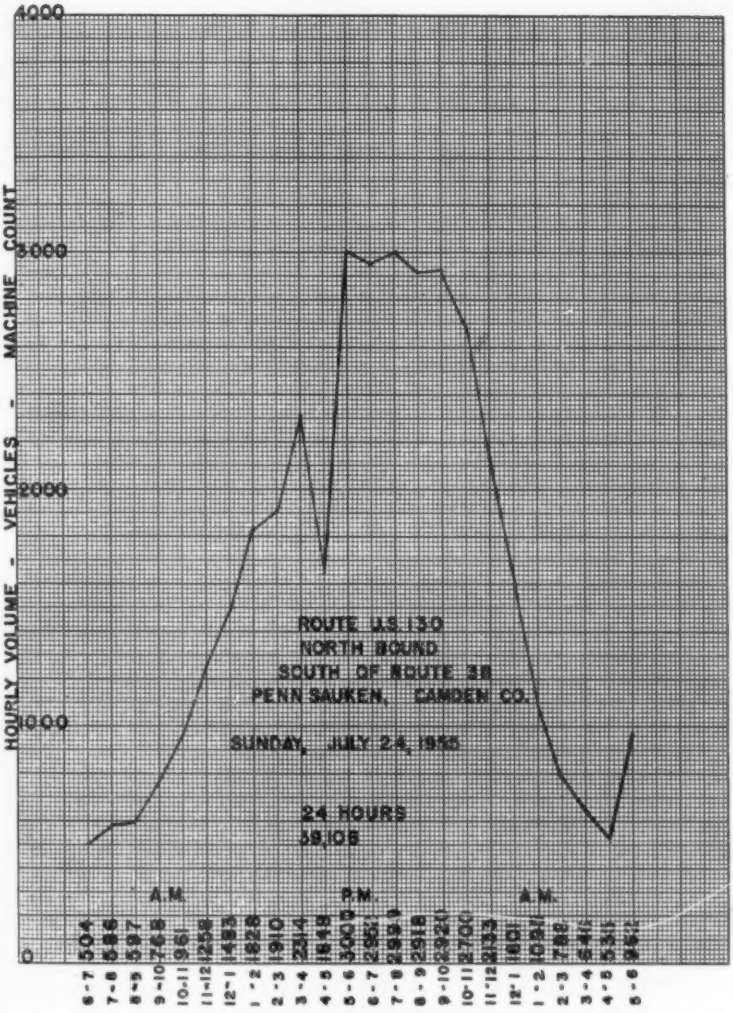

Figure 2. Hourly volumes on a summer Sunday for a New Jersey highway location.

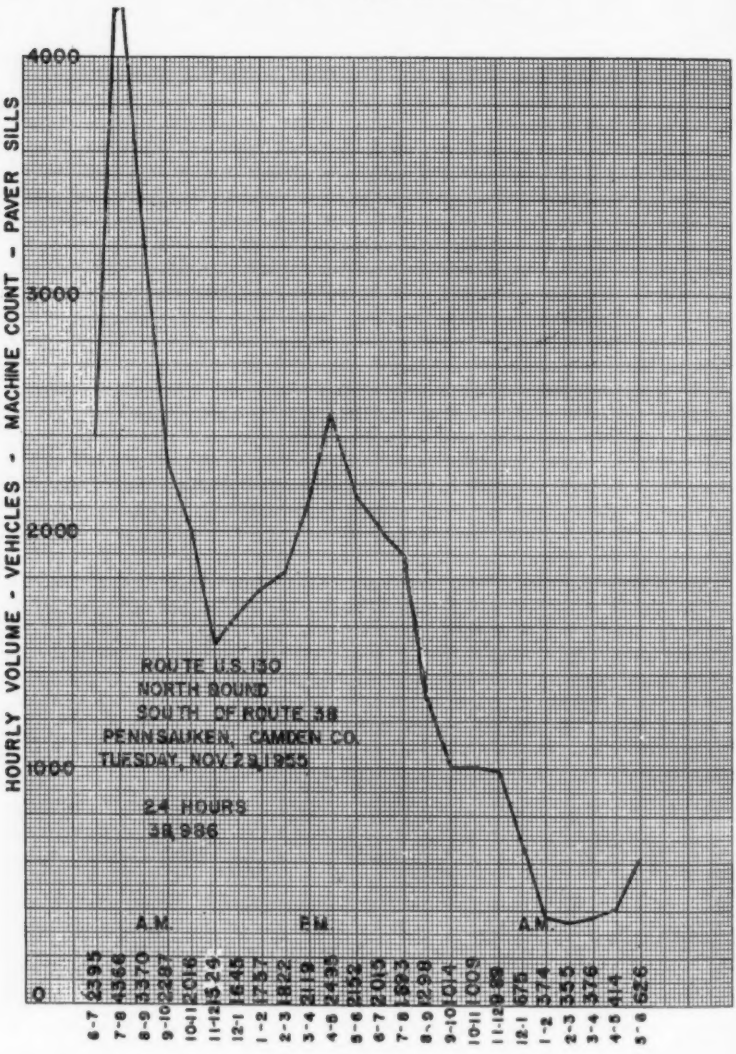

Figure 3. Hourly volumes on the same New Jersey highway during a Tuesday in November.

road is perfect in each direction so that vehicles do not stop but use the entire green phase. The turn prohibitions and the long cycle can be demonstrated.

The perfect progression is more difficult to support. Since the potential of these factors has been explored it seems unlikely that more traffic capacity would be obtained from these sources than already known. When a grade separation is provided, more capacity is provided, but then the intersection ceases to be that defined as a typical city intersection. Our imagination sometimes leads us to think in terms of all east-west streets on one level and all north-south streets on a different level. Our thinking has not been able to solve all necessary details to formulate such a plan sufficiently to make serious recommendations. In any case, such a city would be radically different from those with which we are familiar.

Parking

Prohibition of on-street parking has been used in many places to increase capacity. It is effective, but if vehicles, including buses, are permitted to stop only occasionally and only for a short time, the effectiveness is greatly reduced. Drivers will not use this lane normally if they think that a vehicle ahead may stop. Short-time parking, such as with parking meters, does not increase roadway capacity; in fact it reduces it below the capacity existing if all parked cars remained twenty-four hours a day. With on-street parking prohibited it is necessary to provide off-street parking. This in turn creates problems of access to and from the parking areas which reduce the street capacity. Parking therefore is not a source of additional capacity other than has already been demonstrated.

Pedestrians

Pedestrian behavior in some areas greatly reduces street capacity and in other areas interferes with street capacity only slightly. Even in areas where pedestrians do not cross the path of vehicles in motion, the fact that pedestrians are on the sidewalk reduces capacity because drivers must continually remain alert for fear that a pedestrian may step into the roadway.

This prevents drivers from concentrating their full attention on other driving requirements. If it were impossible for pedestrians to appear within view of drivers, an increase in capacity would result with eventual adjustment of driving habits. This could be accomplished if pedestrians were underground at intersections and within the buildings or underground at mid-block areas.

Curves

Sharp curvature reduces capacity and, like poor pavement surface, has been universally accepted and generally avoided. Nevertheless, turning movements must be made at intersections. Such vehicles interfere with the uniform flow of traffic. Left-turning vehicles, although having a larger turning radius than right turns require, must cross the path of on-coming traffic and pedestrians. Turns in and out of driveways must also be made on sharp radii.

Cross Traffic

Cross traffic, without the aid of traffic signals, of one stream crossing one stream as occurs in channelized intersections or one-way street systems has a satisfactory capacity of 750 cars an hour and an absolute capacity of 1,200 cars an hour. Although insufficient studies have been made, it is assumed by logical reasoning that the capacity is reduced progressively as the number of lanes is increased. Where traffic is not channelized the total traffic in the crossing streams within the conflict area is limited by the above figures.

At signalized areas left turns are often made on the same green phase as the on-coming traffic. In such cases the above rates are applied on an hourly rate of green time.There is no source for additional capacity above present-day good practices.

Driveways and Lane-Width

Driveways limit capacity by cross traffic if they have left turning and sharp turning radii. When driveways are not being used by traffic they still have a limiting effect on traffic because drivers must constantly be alert to the possibility of driveway use.

It is generally recognized that twelve-foot lanes have greater capacity than ten-foot lanes and fixed objects adjacent to the pavement should be away from the pavement. These factors give a feeling of security and comfort. They make it easier to drive. They therefore result in shorter time intervals between vehicles because drivers can give more attention to other driving maneuvers.

If fixed objects could be kept, let us say twenty feet, away from the edge of pavement, greater capacity would be reached than if these obstructions are five feet away because of the feeling of comfort. This extra width is impractical for city streets carrying capacity volumes because an additional lane in the extra width area would provide more capacity than the original number of lanes. Indications are that average lane capacities increase as the number of lanes in one direction increase. This seems to be well supported, including four lanes in one direction. There is a possibility that greater lane width could provide more capacity per average lane.

This source of capacity does not seem available for increasing capacity on existing city streets.

Visibility

Good visibility provides greater capacity than poor visibility. Factors that reduce visibility are horizontal and vertical sight distances, trees and poles along the curb line, distracting signs and lights that interfere with the visibility of traffic signals. These factors are generally recognized and therefore provide no new source for additional capacity.

Shoulders provide greater capacity by providing greater effective width and by providing a place for disabled vehicles off of the pavement. They are not provided along city streets and therefore are not a source of additional capacity.

Properly designed medians can provide increased capacity. Generally, they are designed so as to prevent vehicles out of control from entering opposite-direction lanes. These deterrents or barriers create a mental hazard for the driver by limiting the lateral width. The ideal median seems to be one fifty feet wide with no objects to cause impact or sudden change. They are not a source for additional capacity on existing city streets.

It is generally recognized that grades have a reducing effect on capacity. Where heavy trucks are involved, long grades of one percent reduce capacity, but three percent grades are generally considered acceptable design.

Grades and Speed

These elements provide no practical source of additional capacity above the degree already exercised. The remaining deterrents are discussed as possible sources of increased freeway capacity but could have application for city streets and highways.

The "most efficient" speed has been increasing through the years. The speed which drivers choose for any section of road is the maximum speed that appears reasonably safe for existing conditions. As the factors tending to reduce capacity are removed, average speeds will increase up to a limit not yet determined.

It has been demonstrated that seventy miles an hour can be maintained on well designed highways with reasonable safety but there has been no experience where capacity volumes have been reached on such roads. Conditions can be improved to this degree. At present, it seems that the average driver's capability limits the maximum tolerable speed to seventy miles an hour under the best conditions. The capacity of city streets can be increased if other conditions can be improved to permit higher speeds.

Speed Range

When some vehicles travel at low speed and some at high in the same stream of traffic or where other conditions cause drivers to vary their speed below that of the normal driving speed, capacity is reduced. This maneuver causes a wave action to be carried back as far as vehicles are spaced at capacity densities. This wave action can be observed on some highways and freeways. Although it can not readily be isolated on city streets it is undoubtedly a factor in reducing capacity.

In order to obtain highest capacity efficiency, conditions causing fluctuations in speed must be overcome.

Accidents and Controls

It is obvious that when an accident occurs, the capacity of the road is restricted by disabled vehicles, but even the fact that a roadway is

accident-prone causes drivers to behave cautiously, which has an effect of reducing capacity. If accidents were not to be expected, average time intervals between successive vehicles would be closer.

As we approach maximum efficiency in our efforts to gain a desirable degree of perfection, the easiest areas for improvement are accomplished first. Much effort is being exerted in the direction of automatic control of vehicles to increase efficiency. Such controls do not seem very practical for present-day travel because of their probable high cost. But they probably will be practical for the future. Today's efforts will be groundwork for future success.

Among our accidents there are an unknown small but significant number resulting from a driver's being dead, unconscious, or otherwise unable to control his car. In the future, there will be many more drivers, therefore many more such instances; traffic volumes will be much denser, therefore the probability of collision with other vehicles much greater. Other causes of accidents are controllable but such driver failure can be checked only by automatic controls.

These automatic controls would not be substitutes for drivers but would control the vehicle when the driver fails to behave properly. Detection devices in the roadway and in the vehicle would send messages electrically to control-devices along the roadway or in vehicles only when the driver did not behave in a proper manner. Such devices could be made to slow up, speed up, stop, or deflect the path of vehicles. Such advancement may take many years to accomplish but may come.

Weather

Rain, fog, snow, and ice reduce capacity severely. It is commonly accepted that nothing can be done about it but efforts are being made to overcome fog problems and examples exist where pavements include devices that melt snow or ice on the road surface. The texture of pavement and tires may be further improved to overcome wet pavement problems.

On city streets rain greatly reduces capacity because of the erratic behavior of pedestrians trying to avoid bad weather in crossing streets, and during rain there is more loading and unloading of passengers at curb or on the roadway convenient to the

passenger. This would be avoided if pedestrians did not appear adjacent to the street.

Vehicles

Remarkable progress has been made in the vehicle to the point where it is difficult to imagine further important progress. Nevertheless there may be further progress in deceleration, ease of driving control, and comfort to further increase the efficiency of the vehicle. The improvement of any of these items allows the driver greater opportunity to concentrate his driving ability on other necessary details.

Trip Purpose and Familiarity

It has been observed at many locations that commuter traffic will reach larger traffic volumes before the capacity of the roadway is reached than leisure or recreational traffic. In commuter traffic drivers conform very closely to the same pattern whereas with leisure and recreational traffic many drivers do not adhere to the rigid driving practices necessary for maximum capacity.

Likewise, drivers familiar with a route produce greater efficiency than those who must depend on signs. Commuters are both business-like about their driving and very familiar with the routes. It has been claimed that some commuters recognize the same cars around them day after day and get to know just what the drivers ahead can be expected to do.

City traffic is generally (during peak hours) composed of commuters who also are familiar with the route.

Traffic has tripled in the last twenty years and can be expected to double in the next twenty years and then double again for the following twenty years. Rural road systems can readily be expanded by widening or by additional roads. The same cannot be said for city streets. To widen city streets requires extensive demolition which accelerates decentralization. To provide additional city streets the additional streets must be outside the city. This also accelerates decentralization. The fact is that our cities, now overcongested, can not be made to accommodate the growth of traffic that we have or may expect.

The future will experience brand new cities (if they can be

called cities), designed to fit the automobile, which will expand horizontally rather than vertically without municipality boundary limits. Their population density will be limited so that over-capacity volumes of traffic will not result.

Many of our city streets not operating efficiently can be made to carry double their present traffic without physical alteration, but streets *now* operating efficiently cannot be made to carry more traffic. Reconstruction is a gamble in competition with decentralization.

Tourists and Traffic in Hawaii and in Miami Beach, Florida

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THE Territory of Hawaii consists of eight major islands, seven of which are populated. The chain of islands lies northwest-southeast in the Pacific Ocean. Its overall length, from one end of the Island of Kauai to the opposite end of the Island of Hawaii, is nearly four hundred miles. Most of the people live on the island of Oahu, where Honolulu and Waikiki are situated.

The island chain and the locations of existing and proposed tourist developments discussed in this paper are shown in Figure 1.

Because the typical Hawaiian tourist does not have his car with him, his behavior is somewhat different from that of the typical tourist on the mainland, or continental United States; he is entirely dependent upon public or hired transportation. This fact apparently has not been a deterrent to the growth of Hawaii's visitor industry. In 1930, 18,500 tourists visited Hawaii. In 1957, the number had increased to 169,000 persons.

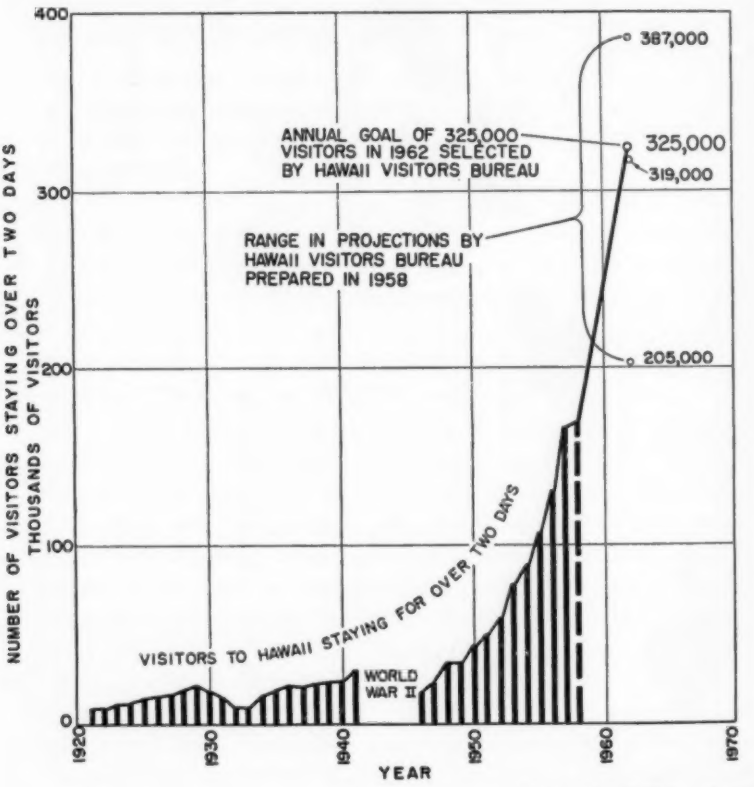
Growth in the last seven years, averaging about twenty percent annually until the current year, has been impressive. Furthermore, the Hawaii Visitors Bureau Research Committee has set as a goal 325,000 tourists for 1962. This growth trend is shown in Figure 2. To accommodate these visitors, there must be a major expansion of present resort facilities, as well as a rapid evolution from the draw-

Figure 1. Hawaiian Islands.

ing board to completion for several new resorts. Careful studies must also be made to best accommodate the vehicular traffic that will be generated by these visitors.

Tourists and Traffic

In a review of tourists and traffic in Hawaii, a look at car ownership, population, and the use of automobiles is helpful. In 1930, there were 49,000 registered vehicles in the Islands. By 1950, this regis-



Source: Hawaii Visitors Bureau

Figure 2. Visitors to the Territory of Hawaii, showing short term projections by Hawaii Visitors Bureau.

tration had increased to 141,000 vehicles. Registrations continued to increase at an average rate slightly in excess of five percent each year and, as of December 31, 1957, 200,000 vehicles were registered in the Territory. Of these, 150,000 were on the Island of Oahu.

Since there are approximately 256 square miles of land flat enough to be usable on Oahu, this island has only an acre of land for each vehicle. In contrast, New Jersey has two acres per vehicle, Illinois ten, and Indiana twelve acres per vehicle. All taxable and non-taxable passenger cars, trucks, tractors, buses, hearses, ambulances, cranes and motorcycles are included in these totals, with the notable exception of a large number of vehicles operated by the Armed Services. Thus, the vehicle concentration is even greater than the above figures indicate.

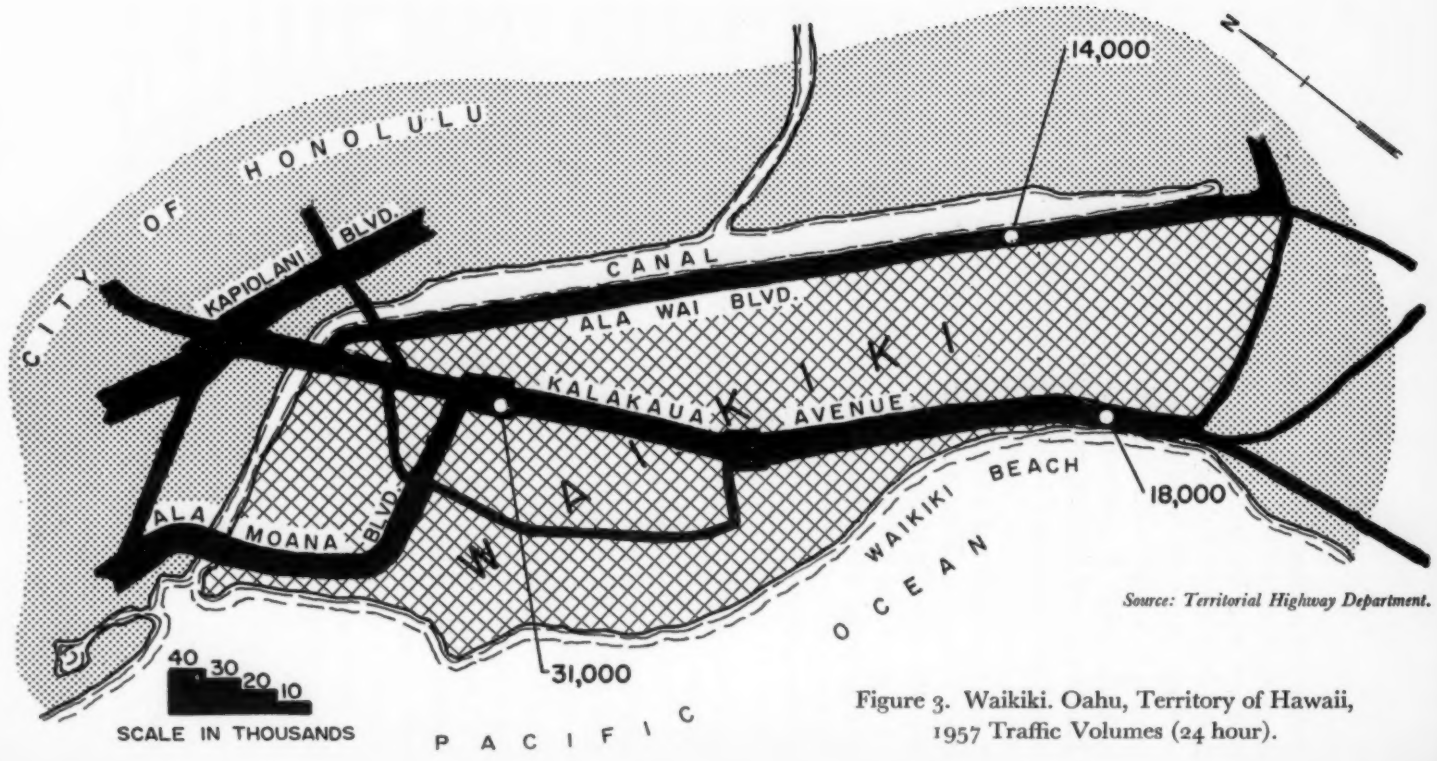
What about the population of the Territory of Hawaii? The civilian population of the Islands, as estimated in July, 1958 by the Territory's Department of Health, Bureau of Health Statistics, totals nearly 576,000 persons. More than 443,000 of these are on the Island of Oahu alone. Since the July 1957 population of Oahu was 416,000, this represents a gain of 27,000, or 6.6 percent, within the last year.

The totals include dependents of servicemen, but not the servicemen themselves. An exact count of servicemen is not available, but conservative estimates place their number at about 45,000. Thus, combining these two estimates brings the total population of Oahu as of July, 1958 to approximately 488,000, or nearly 800 persons per square mile, a one-third greater density than found in Japan.

These figures indicate one registered vehicle for every 3.2 people on Oahu. These people, this concentration of vehicles and the resulting traffic are a part of one of the most attractive and interesting tourist areas in the western world.

Interviews, to establish tourist use of automobiles, were held with automobile rental agencies on the island of Oahu. The results show that in 1957 tourists accounted for 57 percent of all rental automobiles used during that year for a total of 45,000 automobile days. Servicemen, businessmen and people from other islands accounted for the remaining 43 percent of rental automobile operations.

During 1957, 169,000 tourists spent two days or longer in the



Source: Territorial Highway Department.

Figure 3. Waikiki. Oahu, Territory of Hawaii, 1957 Traffic Volumes (24 hour).

islands, with the average stay being about three weeks. These figures represent about 3,500,000 tourist days. Assuming that two tourists occupied each rented car, then these automobiles were used during 2.6 percent of the total tourist days.

Waikiki, Oahu

The hub or center of Hawaii's tourist industry is a 440-acre table-top flat area only a few feet above sea level and entirely within the City of Honolulu, known as Waikiki. Once mainly swamps and duck ponds, it is now drained by an attractive tangential 200-foot-wide canal nearly two miles long. This canal somewhat parallels the ocean and almost makes an island of Waikiki. Not only is it handsome, but it is a significant physical feature. As such it has influenced urban growth and street patterns.

Long before the ponds were drained, the sandy beach areas of Waikiki were popular. In fact, the earliest Hawaiian settlements were in Waikiki, and only 125 years or so ago, modern downtown Honolulu sprang up around the harbor four miles away. Kalakaua Avenue, the main street of Waikiki, had its origin as a road along the beach. Today, this road along the beach is the only direct route traversing the "island" of Waikiki. It is supplemented by a road paralleling the canal, and known as the Ala Wai. Figure 3 shows today's traffic on these routes.

Because Honolulu's street pattern outside this Waikiki island does not include convenient bypass routes, and perhaps partly because the pedestrian scenery is usually attractive, even to the driver-by, Waikiki seems to attract about fifteen to twenty thousand cars per day that are merely passing through. This is an estimate, since current detailed origin-destination figures are not available. But herein lies a part of Waikiki's traffic problem—the through-driver or the non-stop traffic.

A study in 1954, prepared for the owners of several large hotels in Waikiki, revealed that for each hotel room in Waikiki eight vehicular movements per day were generated in the immediate area. While tourists may not be using rental cars all the time, certainly the limousines, buses, laundry trucks, hotel service vehicles, local residents picking up visitors, and similar movements associated with tourist trade provide a large measure of the moving traffic.

The number of hotel rooms or units in Waikiki has increased from about 1,000 available to tourists the first two years after the war to about 4,300 today. In addition, there are more than 5,000 apartments and about 1,000 homes in Waikiki.

Proposed Aids for Traffic Problems

Traffic problems in Waikiki have been, over a period of time, the subject of studies by various agencies, including the City Planning Commission of Honolulu. The Commission has proposed several steps to meet these problems:

1. Limiting the density of land occupancy through more stringent restrictions on building heights and setbacks, as well as greater provision for off-street parking;
2. Constructing a medial strip on Kalakaua Avenue;
3. Realignment of Kalakaua Avenue through central Waikiki;
4. Provision of additional major off-street parking facilities;
5. Developing a bypass route.

The proposal for limiting densities has caused much local discussion. The availability of land and correspondingly high costs are cited as factors against strict density controls. Land in Waikiki is now selling for as much as $35 a square foot, a fact that makes adoption of such controls difficult.

In 1953, the Chamber of Commerce proposed that Kalakaua Avenue be relocated between the Royal Hawaiian Hotel and a point past Monsarrat Avenue. While this suggested relocation would provide beach frontage for six additional hotels, it would not afford any real relief to Waikiki traffic problems. This proposal was considered at length, and appeared in modified form in a later study.

In a subsequent study sponsored by the Honolulu chamber of commerce and directed by the city planning commission, consultants from Los Angeles and Houston agreed that the heavy streams of through-traffic now reaching Waikiki should be diverted. Their study, completed in 1954, recommended construction of a major route along the north bank of the Ala Wai Canal, with a direct connection to Ala Wai Boulevard. The necessary widening of Ala Wai Boulevard would be achieved by encroachment onto the Ala Wai Canal.

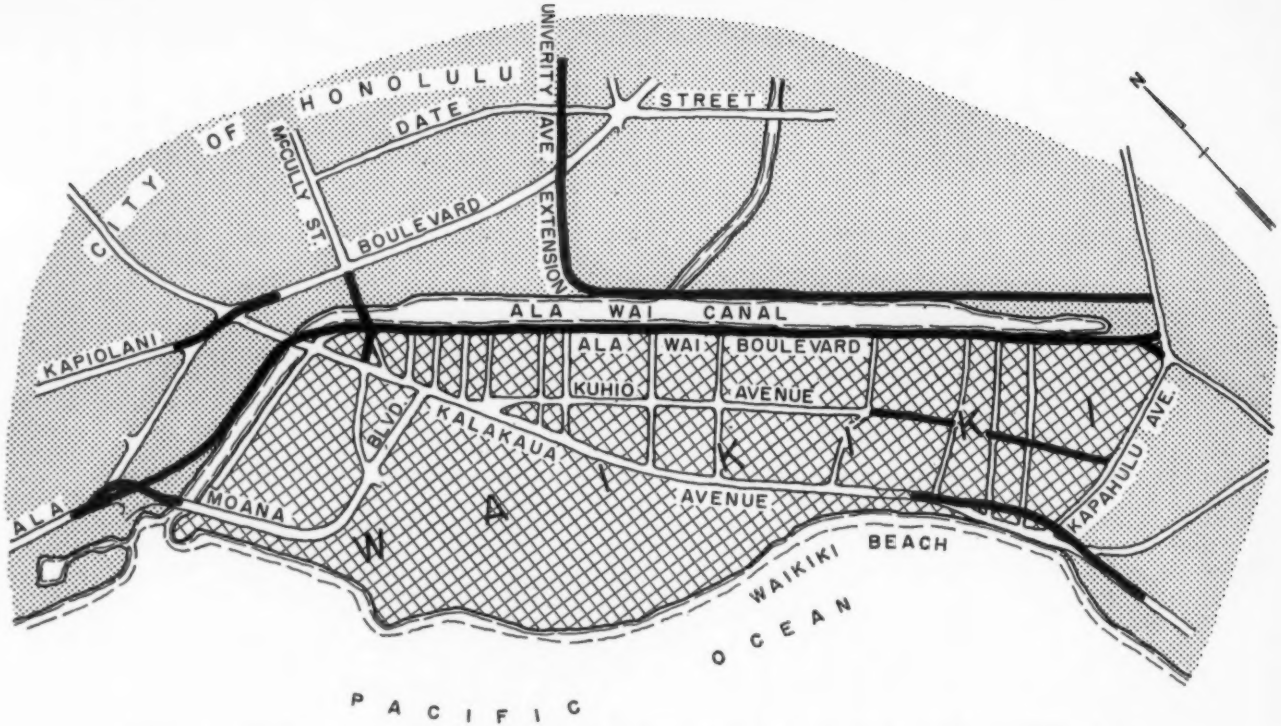


Figure 4. Waikiki. Oahu, Territory of Hawaii. Bennett-Maier Street and Traffic Proposal, 1954.

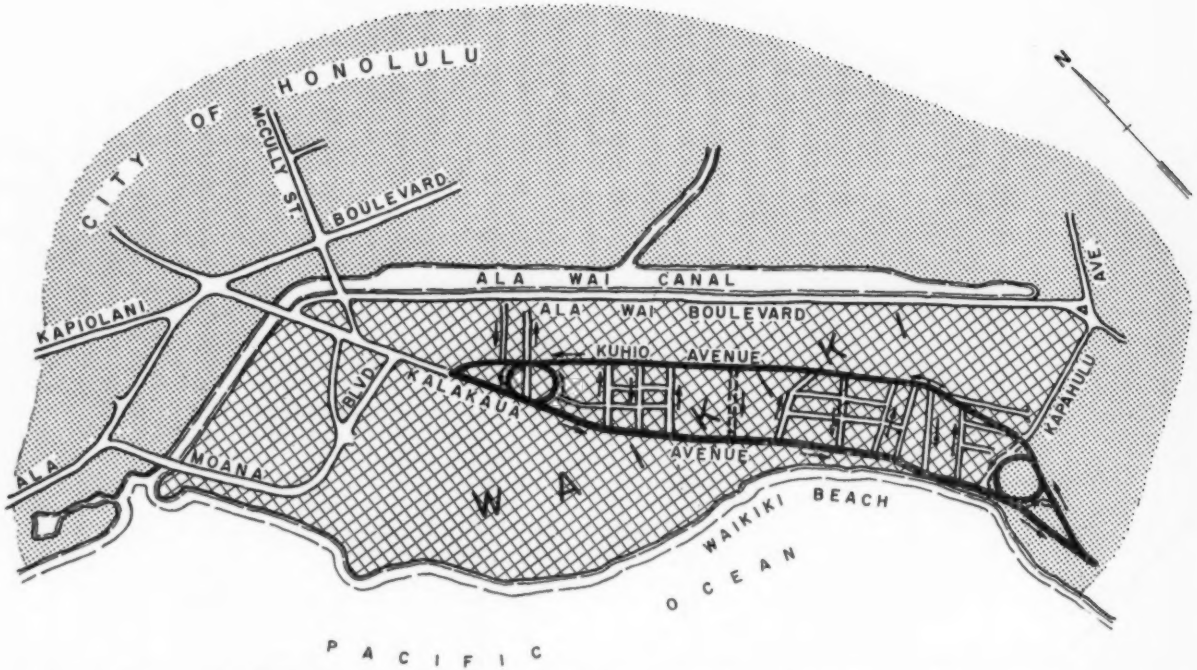


Figure 5. Waikiki. Oahu, Territory of Hawaii. Belt-Collins Street and Traffic Proposal, 1954.

The roadway thus constructed would serve a two-fold purpose: first, it would provide a major feeder road, with well-regulated and adequately spaced intersections for vehicles with origins or destinations within the Waikiki complex; and second, it would also divert through-traffic along the fringe of the Waikiki island without destroying the effect of local street frontage of lots along Ala Wai Boulevard. Figure 4 shows certain street and traffic aspects of this proposal.

Following receipt of the 1954 study by Honolulu traffic engineers for the hotel owners, the same hotel company put forth another proposal to solve traffic problems in the area. This plan proposed to extend Kuhio Avenue, which also parallels the ocean. This street and the parallel section of Kalakaua Avenue would then be used as one-way streets. Rotary traffic movements at the two connections between Kuhio and Kalakaua Avenues would permit a natural and orderly transition from two-way to one-way traffic. This scheme is shown in Figure 5.

Routing Through-Traffic Around Waikiki

Waikiki traffic was also the subject of a 1955 study by the students of city and regional planning in Cornell University. They recommended that the greater portion of through-traffic should be routed around Waikiki. This change would be accomplished by extending Ala Moana Boulevard to Kapiolani Boulevard, and constructing grade-separation facilities both at the present Ala Moana Boulevard Bridge and at the intersection of Ala Moana and Kapiolani Boulevards.

Access to the Waikiki resort area would be provided at the present Ala Moana Boulevard Bridge and at a new intersection at McCully Street. A serpentine street pattern, modified to use existing street rights-of-way wherever possible, would be superimposed on the existing street pattern within the Waikiki area. Adequate circulation to all parts of Waikiki would thus be provided while at the same time large "super-block" neighborhoods, each with its central open space, would be created. Access to the centers of these superblocks would be furnished by secondary streets and cul-de-sacs. These would be narrower than the major thoroughfares, both be-

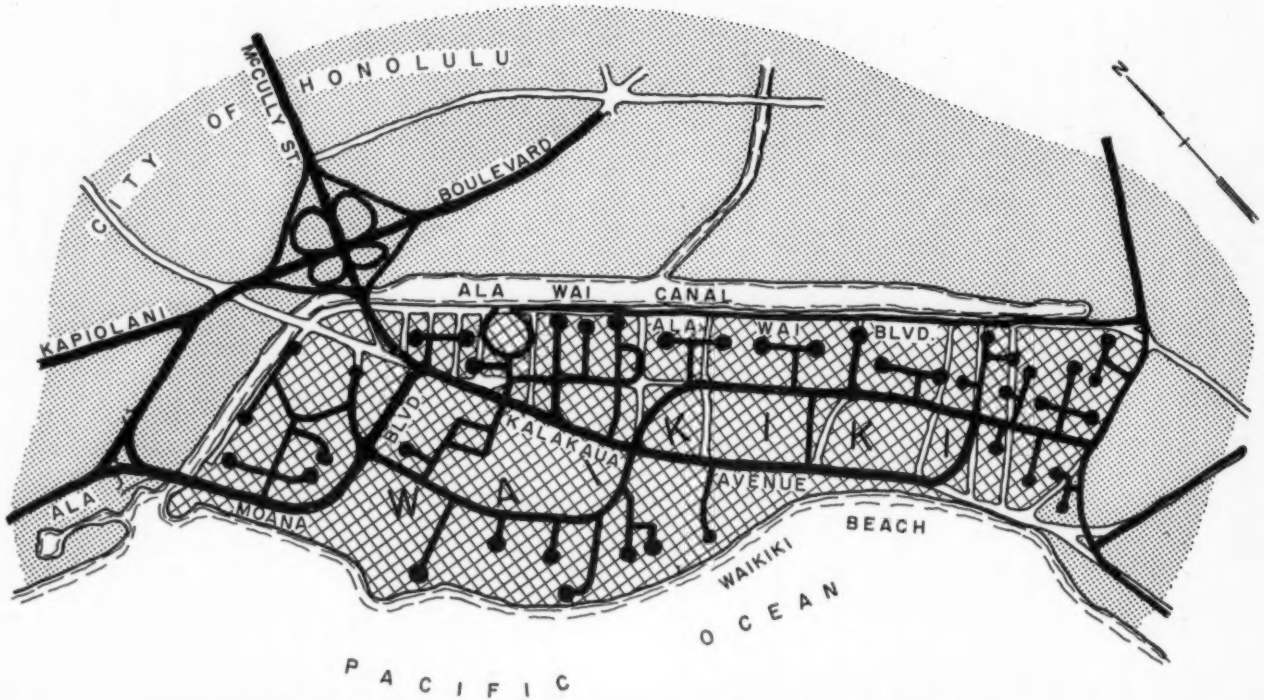


Figure 6. Waikiki. Oahu, Territory of Hawaii. Cornell Street and Traffic Proposal, 1955.

cause of smaller traffic volumes to be carried and as a means of discouraging through-traffic.

The Cornell study contained some imaginative and interesting approaches to the traffic problem, and represents a significant piece of collegiate work. The street pattern proposed in the Cornell scheme is shown in Figure 6.

At the same time several positive steps have been taken to divert traffic from Waikiki to the north. The Mauka Arterial, a territorial highway, will relieve Kapiolani Boulevard; in turn, by a chain reaction process, this improvement will relieve to some extent Ala Wai Boulevard, Kalakaua Avenue, and Ala Moana Boulevard. A large segment of this arterial is now in service. This highway will provide a direct route to the center of Honolulu from the areas north of Diamond Head. Similarly, other area improvements will provide another direct traffic route between the Diamond Head area and downtown Honolulu.

City and territorial officials continue their efforts to develop and carry out a street and traffic plan that adequately provides for both present needs and future anticipated growth in the area. Difficulties in accomplishing this purpose can be traced to the multitude of area interests combined with the characteristics of the problem.

Early in 1958, the city planning commission staff undertook a detailed review of Waikiki land use, the officially adopted proposals for street widenings and extensions, and is now working on further proposals for land-use controls and traffic improvements. But in addition to official action, implementation of proposals for solving Waikiki's traffic problems will require community understanding of these problems. The area is, and will continue to be, an outstanding resort center. Its traffic situation is not dissimilar in character or scale to those of hundreds of other American communities; its traffic problems must and can be solved.

Wailea, Maui

Plans are getting underway for a major resort on the southern shores of Maui. This area, comprising several hundred acres, will be developed by the Matson Navigation Company. At the present time, the property is largely undeveloped. Although an existing private

road traverses the area's lower portions, it is unimproved and can be easily relocated away from the beach areas. The major road problem will be to create approaches that will help to establish the desired character for the resort area.

According to present plans, the majority of tourists will arrive by air at Kahului Airport, some fourteen miles from the proposed resort. The trip from the airport will be made generally by limousine or rented car. Obviously, the first impressions of tourists during this journey may well set the mood for their entire stay on Maui.

In traveling the relatively short distance from a major transportation terminal to his destination, a tourist is interested in a comfortable ride and attractive scenery. He usually is unhurried and speeds seldom exceed thirty-five miles per hour. Thus, from the Hawaiian tourist's standpoint, a reasonable amount of time consumed in travel—so long as the drive has esthetic appeal—is not an important consideration.

Design standards for this type of use should emphasize well-landscaped right-of-way and natural topography to permit interesting views at the design speed. Also involved is the element of scale, wherein the engineer must relate curvatures, grades and plant materials to the over-all picture viewed by visitors and local people using the road. This esthetic approach to highway design can create a pleasing and attractive road and at the same time provide a traffic route that will be economical to construct and maintain.

The location on Maui of both the Wailea and Kaanapali sites is shown in Figure 7.

Kaanapali, Maui

Kaanapali, on the western shore of Maui, is thirty-three miles from Kahului Airport and five miles north of the town of Lahaina. It has a magnificent sand beach two miles long. It is served by a highway that continues as an unimproved trail around the West Maui Mountains. The highway adjacent to the proposed Kaanapali resort area approaches the beaches in several locations.

A relocation of the highway is now underway so that adequate land is available for resort development and to permit the desired separation of resort traffic and through-traffic. This, in effect, easily accomplishes what is so often difficult to do in Waikiki; it will place

the highway on the mountain side of the resort, thus providing an island effect for the entire resort area. Hotels and resort activities will be served by feeder roads from the main highway, each one ending in cul-de-sacs. Through-traffic, which will increase as West Maui develops, will be allowed to proceed without hindrance.

The plan for Kaanapali, shown in Figure 8, provides for two thousand hotel rooms on the ocean frontage at a density of twenty units per acre. Moving the highway away from the resort area leaves

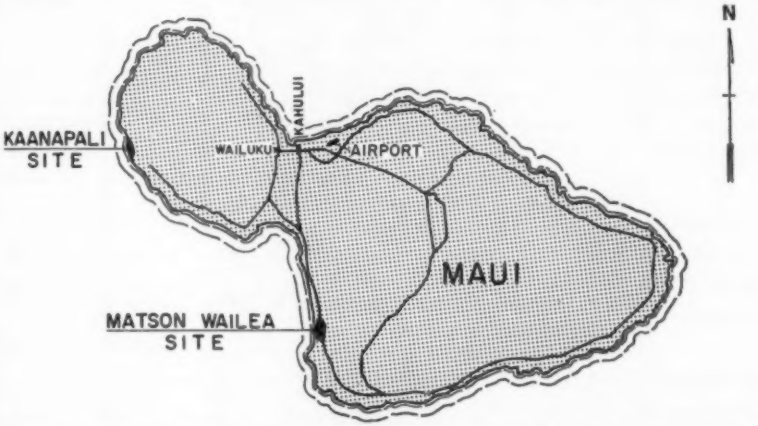


Figure 7. Kaanapali Resort, Wailea Resort. Maui, Territory of Hawaii. Location Plan.

room for a golf course with ocean frontage, a major tourist, commercial, and convention center, and extensive horseback riding and polo field facilities all related to the hotel area proper without any division factors. Horseback trails will extend into the gulches and on up through the West Maui Mountains.

Kailua-Kona—Island of Hawaii

A regional plan is now being prepared for the Kona District on the western shores of the Island of Hawaii. This district's area is approximately eight hundred square miles. When the plan is completed, detailed development plans will then be prepared for major tourist facilities within the district.

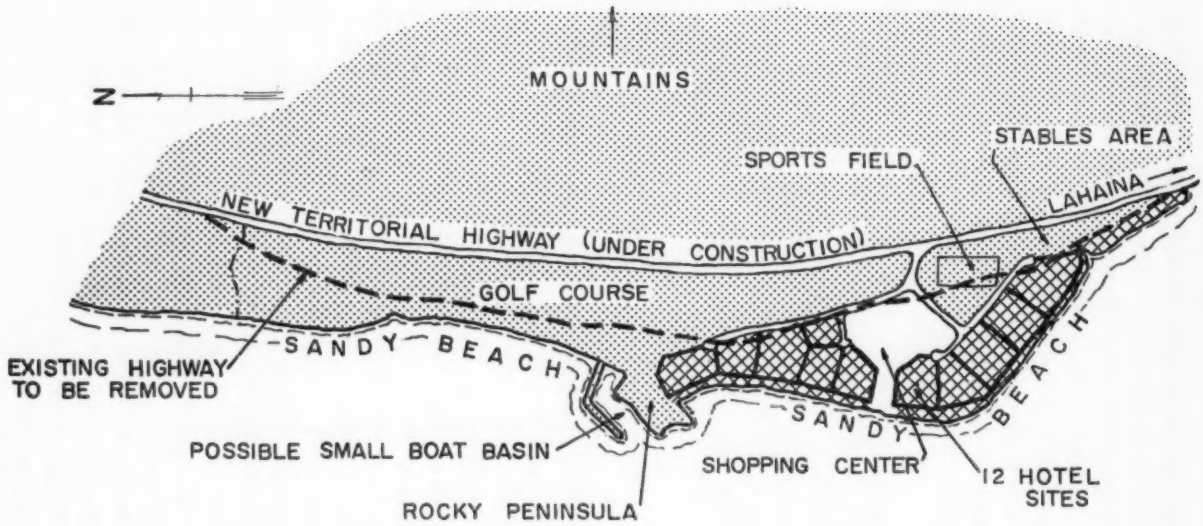


Figure 8. Kaanapali. Maui, Territory of Hawaii. Development Plan.

Of the potential resort centers, Kailua-Kona on Kailua Bay is most developed and offers the best opportunity for immediate expansion of resort facilities. The present population of this pleasant, relaxed, typically Kona-style village is eight hundred, and its ten small hotels and motel-type units provide a total of about two hundred rooms. Expansion to fifteen hundred rooms is contemplated for this area. A Kona Citizens Advisory Committee on the Kona plan, taking an optimistic view of the district's potentialities, stated:

> "Kona today is the most important tourist area in Hawaii outside of Waikiki. Yet there are only 155 hotel rooms (as of 1957) and its facilities are critically overcrowded at peak periods. Nevertheless, assuming the development of an adequate water supply, the Kona coastal area possesses the most promising potential for becoming the next destination area."

Although detailed plans are not yet completed for Kaulua-Kona, a major consideration in its growth is to preserve the appearance and character of existing villages. These have already been affected to some extent by traffic congestion along the winding beach road known as Alii Drive.

One proposed solution now being studied (shown in Figure 9) interrupts traffic flow along Alii Drive by severing this route at strategic points. The major access for vehicular traffic would be provided by a new highway alignment approximately five hundred feet back from the existing route which connects to the modern Kuakini Highway. The major objectives of this suggested realignment are to:

1. Preserve the existing shore route Alii Drive as a scenic and relaxed approach to hotels and historical sites;
2. Preserve Alii Drive as an uncrowded access road to all residential shore property; and
3. Create potential hotel sites in optimum locations with a greater depth between the access road and the shore.

Existing highways provide ready access to the Kona Airport; Kuakini Highway, recently completed as a high-speed route, provides connection with the major round-the-island main highway. The proposed modification of the traffic-circulation pattern will contribute to the resort area development by providing ready access

to a new small boat harbor, a new golf course, the airport, and an outlet to scenic and historic spots nearby.

Breaking Alii Drive as shown on the proposed plan, can create pedestrian mall areas adjacent to the shore. Hotels on the mountain side of the drive will have views and access to the ocean, uninterrupted by highway traffic.

This brief outline of tourist and other vehicular traffic in Hawaii has emphasized the importance of separating the two types of traffic. Hawaiian resorts are being planned to avoid future traffic conflicts similar to those in Waikiki. The basic principle of creating a resort island, with feeder lines from main highways, has been found to be workable and satisfactory.

All studies of Waikiki traffic agree on one point: through-traffic must be diverted from the heart of the site by a simple and direct route.

The Wailea resort is still in the planning stage, while Kaanapali already has a new territorial highway under construction as recommended for maximum use of the site. The Kailua-Kona resort is being carefully analyzed, with all phases of traffic circulation included, and development plans can be expected as the next step. All indications are that Hawaii will have a variety of well-planned resort areas in the very near future.

Tourists and Traffic in Miami Beach

Any consideration of traffic and parking in Miami Beach should be prefaced with a review of those conditions, peculiar to that city, which exert a strong influence on the nature of its problems and their solutions. Admittedly, many of Miami Beach's characteristics are common to many other communities—rapid population growth, a large amount of recent construction, the development of high density areas that become heavy traffic generators, and the relative unavailability of property needed for off-street parking or major street rights-of-way because of high costs. But it is the unusual factors that have shaped the character of existing traffic and parking facilities—these and a long-range planned approach to the problems.

First of all, Miami Beach is essentially an island. It is connected

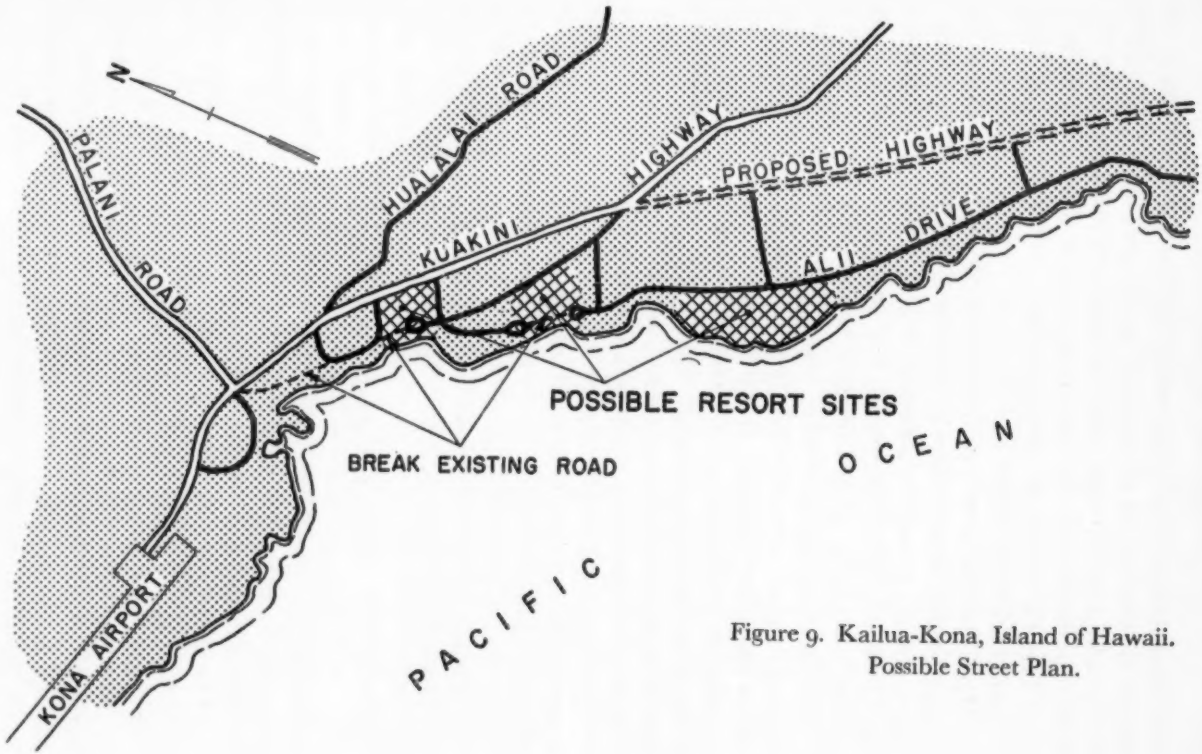


Figure 9. Kailua-Kona, Island of Hawaii.
Possible Street Plan.

with the mainland by only four traffic routes, three over water. Although the city has population and municipal facilities enough to be self-sufficient, travelers drive to and from work each day between the Beach and the mainland portions of the metropolitan area. There is almost no through-traffic, but an unusually large volume of inter-city traffic.

Miami Beach has no predominant traffic generator such as the normal central business district in most cities. Miami Beach embraces a series of major generators including commercial centers, high density hotel development, and large recreational facilities more or less equally spaced along its six-mile length.

The interrupting pattern of water adds immeasurably to the city's charm and attractiveness, but also adds to the difficulty and cost of providing adequate and well-aligned traffic arteries. Construction of municipal facilities requiring additional land is hampered by the shortage of acreage. Only five percent of the total land area in Miami Beach is now vacant, and at the present rate of development all vacant land will be absorbed in five years.

The final factor which is peculiar to Miami Beach is the large seasonal ebb and flow of population. Because of the heavy influx of tourists, population during the peak season is nearly three times that of the off-peak, or summer season. For example, population varied from 50,000 to 130,000 in 1957. This seasonal change has been surprisingly consistent since 1940.

New Major Street Plan in 1957

Miami Beach, considering its characteristics and the complexity of its problems, has made remarkable progress in the development of a major street system and off-street parking.

The existing system of major streets resulted from a long period of careful planning and a persistent adherence to the plan. The original major street plan drafted in 1940 provided for a network of major streets interconnecting all existing and expected neighborhoods and primary traffic generators. An important feature was an improved connection with the mainland and relief of congestion in the rapidly developing northern portion of the city.

Now, eighteen years later, a significant part of the total system

has been built or is under construction. Connections with Miami are being improved by eliminating a draw span on one causeway, and constructing a new causeway without draw spans. Many of the major north and south routes accord with standards considered adequate to meet ultimate requirements. Bridges on internal routes have been widened or replaced, and the more difficult intersections have been relieved by grade separations. It is worth noting that all major street improvements since 1940 have conformed with the plan, both as to location and design capacity.

In 1957, the major street plan was re-evaluated in light of new land-use studies and population projections. This plan was co-ordinated with plans of the state road department, and with plans for other sections of the metropolitan area.

Essentially, the new street plan is a revision and extension of the 1940 plan and recognizes the need for increased capacity to accommodate the ever-growing volume of traffic. Daily inter-city traffic over the three causeways nearly doubled between 1940 and 1957 (63,000 to 112,000). On the basis of current population trends, automobile ownership and automobile use, this volume is expected to more than double again by 1980.

In 1957, the peak-hour total traffic over three causeways was approximately 9,000 cars. By using four causeways with an uninterrupted flow, this figure is expected to reach 19,000 cars by 1980. The causeways can be improved to accommodate this traffic. The internal major street systems on both sides of Biscayne Bay must be improved to distribute such high volume without congestion. Major provisions of the current plan are:

1. to eliminate draw spans on all causeways (now a major cause of delay);

2. to complete the major north-south routes in the northern half of the city;

3. to construct a causeway-bypass of a natural traffic barrier wherein the city's land area is actually not wide enough to provide the required lanes of traffic;

4. to add one additional east-west route to serve the fourth causeway, now under construction;

5. to increase capacities of existing routes by improvement of critical intersections; and

6. to continue the development of off-street parking facilities to release additional street right-of-way in congested areas for moving traffic.

Off-Street Parking Increased

Miami Beach's record of achievement in providing off-street parking facilities was reviewed in the July 1951 issue of *Traffic Quarterly*. Begun in 1940 and greatly expanded after World War II, the system of off-street municipal parking lots has increased from a single lot with 100 spaces in 1940 to twenty-five lots with 4,231 spaces in 1957.

Miami Beach has a total of 33,000 parking spaces of which fifty-seven percent are curb spaces, thirty-one percent are in privately operated off-street facilities and twelve percent are in municipal lots.

As part of the 1957 plan an analysis of population, land use and parking was made. Results indicated that hotel and apartment areas of greatest population concentration were the most deficient in parking facilities. To date, the city's efforts predominantly have been to provide off-street parking facilities to serve commercial areas.

To assess the scope of the parking problem, the city was divided into fifteen homogeneous districts in which parking was, or was expected to become a problem. Each district had widely divergent parking requirements generated by their basic land use—that is, land used for hotels and including all oceanfront areas with high population density; business and industrial areas having high traffic generation and heavy parking demand, and areas with small apartment buildings to some degree intermixed with commercial.

The greatest inadequacies occurred in the commercial areas, particularly Lincoln Road and the intensively developed hotel strip along the oceanfront. Both of these areas will be improved by additional parking resulting from double-decking the existing Lincoln Lane lots, now under construction.

Upon completion of currently planned additional off-street parking, the commercial areas should be adequately served. The major problem remaining will be to provide off-street spaces in congested areas of large hotel and apartment development. At the present time a combined parking deficit of about 2,300 spaces impairs the operation of both streets and hotels.

This latter problem points up a need for constructing private facilities in conjunction with new high density residential uses. The city has encouraged this solution in many ways, including a requirement for such facilities contained in the zoning ordinance. However, in a city with only five percent of its land still vacant, and with many districts having no vacant land, relief by these means is unlikely.

Because of the financial success of the city's parking efforts to date, the program is being broadened to include the remaining aspects of the problem. A comprehensive plan for adequate off-street parking for all land uses, so necessary to this resort community, is being prepared. Because of its past record in this activity, the city is expected to succeed.

Co-operative Expressway Planning in the Tulsa Metropolitan Area

SHERMAN W. GRISELLE AND HERBERT S. LEVINSON

Mr. Griselle has been Principal Planner with the Tulsa Metropolitan Area Planning Commission since 1956. Previously, he was associated with the City Plan Commission of Lansing, Michigan. He is a member of the American Institute of Planners and the American Society of Planning Officials, and holds a Master's Degree in Urban Planning from Michigan State University.

Mr. Levinson, an Associate Engineer with the firm of Wilbur Smith and Associates since 1952, has been engaged in a variety of traffic projects, including studies related to expressway planning in the Tulsa Metropolitan Area. He is a member of the Institute of Traffic Engineers, and the Highway Research Board, and is a graduate of the Yale Bureau of Highway Traffic and the Illinois Institute of Technology. He is a registered engineer in New York and Connecticut.

NEW expressway nets, linking the entire metropolitan complex, have altered the established patterns of community living. Planning an urban expressway system should be fully co-ordinated with other urban functions and with overall community development. It should consider the broad phases of city planning and co-operate with all other agencies interested in planning, development, operation, control, and general welfare of the city and its suburbs.[1]

As the national highway program progresses, it is increasingly apparent that co-operation and co-ordination are the key to successful development of urban expressway systems. This co-ordination is essential if the intent of the Federal Aid Highway Act of 1956 is to be carried out; it has become one of the more difficult problems facing the national highway program.

Many agencies contribute to the welfare and progress of the metropolitan region. Planning, school, park, recreation, utility,

1. *A Policy on Arterial Highways in Urban Area*, American Association of State Highway Officials, 1957, page 66.

police, fire, traffic, and highway officials all must work in close co-operation in the development of long range regional plans. Conflicts that arise when urban expressway location and design are not integrated with plans of other agencies can usually be resolved through *co-operative* expressway planning; at the same time, opposition, which could seriously hamper the overall highway planning, can be minimized. The accelerated pace of projected urban renewal and redevelopment makes the need for integration of highways and land development even more imminent.

The need for co-operative expressway planning has been long recognized in the Tulsa area. Accordingly, a co-operative expressway planning program in the Tulsa metropolitan area was begun in the summer of 1956, as a result of preliminary investigations. This program, undertaken over the last two years, has attained close co-ordination of all agencies; the recommended expressway system has been favorably received throughout the metropolitan area. This article discusses the background, organization and accomplishments of the Co-operative Expressway Program.

Background

Greater Tulsa is one of America's newest urban areas; the city has developed rapidly during its fifty years of incorporation, growing from 7,200 in 1907 to a metropolitan area population of 325,000 in 1957. With this rapid growth have come the usual urban problems of mixed land uses, traffic congestion, blight, an unco-ordinated street pattern, and a constant struggle to maintain a high standard of public services, parks and recreation facilities, schools, fire stations, and other municipal functions.

A city planning commission was created in 1922. In the following eight years, it adopted a zoning ordinance, sub-division regulations, and a major thoroughfare plan. A county planning commission was established in 1949 when the need for planning in the area surrounding the city had become acute.

The Tulsa metropolitan area planning commission, established in 1953, assumed the duties of the city and county planning commissions. It became the sole planning agency for the City and County of Tulsa (excluding the small incorporated towns in the

county) and parts of two other counties. Commission membership totals twelve; six members are appointed by the city, three by Tulsa county, and one by Osage county; the mayor of Tulsa and the chairman of the Tulsa county board of commissioners serve as ex-officio members with voting privileges.

Responsibility for planning in the Tulsa metropolitan area has been delegated to the Tulsa metropolitan area planning commission by the Oklahoma State Legislature in the enabling act allowing the creation of the commission. The act spells out the planning commission's area of jurisdiction and its specific authority of planning:

"The Commission shall make, adopt, and may publish an official master plan of the municipality, the five-mile perimeter area immediately surrounding such municipality, which, for the purpose hereof, is defined to be an area five (5) miles in width around the city limits of such municipality as such limits now exist or may hereafter be extended, and of the rest of the unincorporated area of the county, for the purpose of bringing about a co-ordinated physical development in accordance with the present and future needs of such area. The master plan shall be developed so as to conserve the natural resources of the area, to insure efficient expenditure of public funds, and to promote the health, safety, convenience, prosperity and general welfare of the people of the area and the state. Such master plan may include, among other things, studies and recommendations relative to the location, character and the extent of highways. . . ."[2]

The technical staff of the planning commission is under the supervision of the director and is divided into three sections: long-range planning, planning administration and office management. (The long-range planning section, along with the director, special consultants and technical advisors, were responsible for developing the expressway program and system.)

Basic Studies: Immediately after its creation in 1953, the planning commission began compiling basic planning maps and data for use in its comprehensive planning. The more important of these studies, which later proved indispensable in the planning commission's expressway planning program, were these:

1. Base maps covering the City of Tulsa and the area within five miles thereof were completed. These maps were developed at

2. 1953 Oklahoma Statutes Annotated, 863. Section 863–7.

a scale of 1 inch to 200 feet and showed major water courses, street rights-of-way, and property ownership lines.

2. Five 7½ minute quadrangles—over 300 square miles of topographic mapping in co-operation with the U.S. Geological Survey—were completed; five additional quadrangles are in various states of completion.

3. Land-use maps comprising some 250 square miles were completed at a scale of 1 inch to 200 feet. These maps showed the location, shape and type of use for every structure within the area mapped, other than single and two-family dwellings which were only approximately indicated.

4. An origin-destination traffic survey for the metropolitan area titled, *Metropolitan Area Traffic Survey, Tulsa, Oklahoma*, and a parking study of the central business district titled, *Tulsa Parking Study*, were completed in 1954–55. Both studies were undertaken, at the request of the Tulsa metropolitan area planning commission, by the Oklahoma department of highways with the co-operation of the Bureau of Public Roads, and were financed jointly by the planning commission and highway department.

These early studies contemplated just such a program as the one later described: "... the Metropolitan Area Planning Commission is charged with formulating a plan for the city's immediate and future development. Since such planning will entail possible changes in major county roads and existing state highways, and the location and development of new routes in the metropolitan area, the planning commission has recognized the need for current comprehensive data upon which to base new concepts of present and future traffic volumes. This information will be used in designating facilities for present and potential traffic needs and, at the same time, will provide factual information for long-range planning."[3]

Planning for Expressways

Within that framework of organization, responsibility, authority, and background of completed work, the planning commission embarked on an expressway study in early 1955. A planning consult-

3. *Metropolitan Area Traffic Survey, Tulsa, Oklahoma*, State of Oklahoma, Department of Highways, 1954–55, page 7.

ant firm was engaged to perform the work; in conjunction with the long-range planning section, two reports were developed.

The first report, *Sketch Plan for Tulsa and the Five-Mile Perimeter Area*, included the following: physical features, land use and employment patterns and population growth trends were analyzed; the extent and location of residential and employment areas necessary to accommodate future population in the metropolitan area were delineated; basic planning objectives and principles were set forth; and a proposed metropolitan area expressway system was developed. The purpose of this report was two-fold: (1) it provided general background planning data, consisting of projections and analyses of the amount and distribution of future population growth (necessary for the intelligent planning of an expressway system) and (2) it proposed a general expressway system for the metropolitan area based on the detailed studies and basic planning principles.

The second report, *Comparative Feasibility of the Proposed Crosstown and Northwest Belt Expressways*, was a study comparing two proposed expressways. The study recommended that both of these routes be developed and pointed out the pressing need for further expressway planning by recommending, "that the planning commission undertake studies in the near future to determine the relative urgency and desirability of all parts of the proposed expressway system. . . ."[4]

Need for a Comprehensive Study: With this phase of the expressway location studies completed, it became apparent that further and more comprehensive study be given to the proposed expressway system. Accordingly, the planning commission investigated the best way to pursue such a study. After discussing the problem with local, state, and federal highway officials, it was decided that the best course of action would be to prepare a proposal setting forth the work that the commission desired to perform and to submit the proposal to the Oklahoma department of highways for approval and financial aid.

It was also decided that the planning commission should obtain official approval and endorsement of the program from the boards of commissioners of the City and County of Tulsa and from local organizations before attempting to undertake the study. This sup-

4. *Comparative Feasibility of the Proposed Crosstown and Northwest Belt Expressways*, Harold F. Wise Associates, Palo Alto, California, July, 1956, page 3.

port was believed essential since there had already been a considerable amount of uncertainty in the past regarding local responsibility for expressway planning in the metropolitan area; several expressway locations developed by the Oklahoma department of highways had been defeated in local right-of-way bond elections.

The planning commission directed its staff to prepare a work program in the form of a proposal to the Oklahoma highway department. This was promptly done and the study was titled, *A Co-operative Expressway Planning Program*, because of the co-operative manner in which it would be carried out. All agencies concerned with expressway planning would play an integral part throughout the entire study.

City and county approval of the program was readily obtained; to secure additional local approval, the staff of the planning commission made numerous public presentations in which the proposed program was explained to civic, professional and service organizations. Over forty pledges of support were obtained; they were generally in the form of a resolution endorsing the planning commission's expressway planning proposal and pledging support to the passage of local bond issues for right-of-way acquisitions.

Backed by community support and a carefully prepared work program, the planning commission submitted its co-operative expressway planning program proposal to the Oklahoma department of highways, and a local delegation appeared before the Oklahoma highway commission on October 16, 1956. The delegation requested approval of the program and further requested that the state execute a contract with the Tulsa Metropolitan Area Planning Commission for the performance of the planning study. The total cost of the study was set at $41,750, and the planning commission agreed to finance a portion of this amount. Approval of the proposal was given by the state in November and the study was officially begun on January 15, 1957.

Co-operative Expressway Planning Program

The study was designated a co-operative expressway planning program because of the informal, co-operative working relationships proposed between all levels of government: city, county, state, and federal. Co-ordination in this manner had sound prece-

dent—the planning commission had previously established a technical advisory committee on highways to review its expressway location studies. This committee, established in 1956, has been composed of:

The city engineer of Tulsa; the city traffic engineer of Tulsa; the county engineer of Tulsa County; one engineer from the Oklahoma department of highways, and one engineer from the Oklahoma district office of the Bureau of Public Roads. Throughout the co-operative expressway planning program, the planning commission, and its special expressway design staff and consultants worked closely with members of the technical advisory committee on highways, as well as with local, state and federal officials.

Special Study Staff Organization: The special staff for the study and its relationship to advisory and sponsoring agencies is depicted in Figure 1. The expressway study was performed by a staff composed of the planning commission's long-range planning section and a liaison officer from the Oklahoma department of highways. This staff was supplemented by planning, economic, and traffic consultants, and an electronic computing firm. Many diverse disciplines and approaches contributed to the expressway planning program:

1. *The General Planning Consultant* rendered general staff advice on all planning matters; prepared basic land-use and population studies; assisted in the development of the 1975 sketch plan, and assisted and supervised the basic traffic projection and assignments.

2. *The Traffic Engineering Consultant* rendered general consultation on basic traffic and transportation values and policies, and special traffic problems; developed a detailed capacity analysis of the existing street system, and prepared a general evaluation of the need and import of an inner dispersal loop.

3. *The Economic Consultant* evaluated the impact of the proposed expressway system on business and residential developments in affected travel corridors.

Frequent meetings between the technical advisory committee on highways, the expressway planning staff and special consultants were held. They served to resolve basic policy issues and co-ordinate the various aspects of the comprehensive program. Throughout the study, the planning commission provided the public with full information regarding the progress of work. Three public presenta-

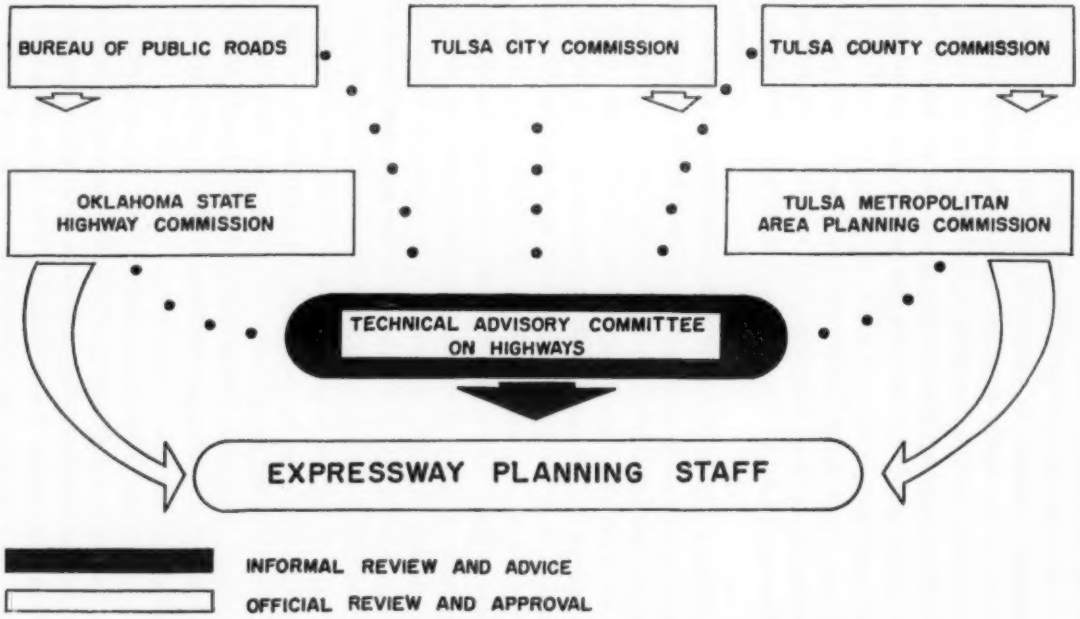


Figure 1. Organization for co-operative expressway planning program.

tions were held to advise civic and other organizations of the progress and findings of the study; in addition, many presentations were made to civic, business, and professional groups.

Objectives and Merits of the Co-operative Program: It was recognized at the outset of the study that the expressway planning must be carried on within the framework of sound objectives and principles of community planning. Specifically, it was the purpose of the co-operative study to develop the general locations of a co-ordinated system of expressways that would fit into existing and projected future development of the Tulsa metropolitan area and provide for the future traffic needs of the metropolitan area. Thus, the expressway system would fulfill the aims of the federal aid highway act of 1956.

Study Phases: The overall expressway program was divided into two related phases. The first phase provided the general urban planning information essential to expressway location planning and resulted in a report, *Metropolitan Tulsa Sketch Plan—1975*. The second phase of the program dealt more directly with the location and design of expressways and resulted in a report, *Metropolitan Tulsa Expressways*.

1. Metropolitan Tulsa Sketch Plan—1975. Much of the basic information was available from previous expressway location studies —studies of natural physical features (e.g., drainage basins, slopes, swamps and flood areas, and rock out-croppings), existing land-use and transportation facilities, and projections of employment and population of 1975. Based on these analyses, future land uses were distributed throughout the metropolitan community in the areas of possible and probable growth. The resultant plan provided a pattern of 1975 land uses that served as a basis for the location of expressways and for the projection and assignment of anticipated 1975 traffic.

2. Metropolitan Tulsa Expressways: Prior to the development of detailed expressway plans and traffic assignments, it was necessary to establish fundamental policies that would serve to guide the location and design of expressways. The basic objectives[5] and principles that comprise the thoroughfare planning policy were

5. In summary, the basic objectives are (a) logical development of the community; (b) safe and efficient movement of people and goods; and (c) economical expenditure of public funds.

approved by the technical advisory committee on highways early in the program, thereby attaining a common basis for the work to follow.

Capacity Studies: The adequacy of the existing street system was measured through roadway-capacity studies made co-operatively with the traffic engineering consultant.[6] Detailed capacities were calculated for each key section of major streets within the metropolitan area. To provide objective bases for computing capacities, special studies were made of (a) traffic, and parking controls, (b) roadway widths and lane usage, (c) peak-hour operating characteristics along key arterials, and (d) vehicular groupings and spacings. Principal capacity deficiencies in the Tulsa area were found to result from:

1. A discontinuity in the street network, especially near the downtown area. 2. Narrow sections of roadway which carry major traffic flows. 3. Intersections of major streets where heavy north-south and east-west volumes cross. 4. A lack of radial facilities. 5. Curb parking, often necessitated by insufficient off-street parking areas.

It was indicated that a radial expressway system would facilitate traffic movements and increase capacity of the major arterial streets by eliminating many left turns at key intersections, thereby simplifying traffic signal phasing. The need for a balance and continuity of capacity was clearly set forth.

Origin-Destination Analyses. In developing the expressway system, it was necessary to know where people wanted to go, both today and in the future. The 1954–55 origin-destination traffic survey contained much of this information; together with projected 1975 land use, it became the basis for a preliminary layout of the system.

In laying out this expressway network, it was necessary to minimize the disruption of established commercial, industrial, and institutional areas, residential neighborhoods, and community facilities such as streets, schools, parks, and airports. The topography of the metropolitan area and the existing regional highway network were also taken into account. With all of these considerations in mind, a preliminary system was developed.

Projection of the 1957 origin-destination data to 1975 levels was

6. See "Traffic Capacity for the Tulsa Metropolitan Area", April 17, 1957, and "Interim Report on Traffic Capacity Factors", June, 1957, Wilbur Smith and Associates.

accomplished by the Fratar method of successive approximations; it involved expanding the number of motor vehicle trips and their destinations as measured in the 1954–55 origin-destination survey in accord with the amount and location of community development anticipated in 1975. The metropolitan area was divided into 99 zones and the trips between each zone and all other zones were tabulated. The number of trips between any two zones was associated with the population, type and intensity of land use, car ownership and ease of travel between zones.

Anticipated changes in population, land use and intensity of development for each zone, along with an estimate of increased automobile ownership and use, formed the bases for the predicted 1975 traffic flows. The shortest route in terms of travel times between zones was calculated for both expressways and major streets to determine the percentage of traffic that each would carry between any two zones. (Generally, a percentage of the traffic between zones was assigned to expressways and the remaining traffic to major streets.) Assignments were based on the time-ratio curves compiled from the observed use of expressways currently in operation throughout the country.

When the assignments of traffic from each zone to each other zone in the area for each segment of the expressway had been completed, the total traffic for each expressway was calculated. In developing anticipated future volumes, an electronic computer was used to project existing traffic to 1975 levels, and to assign trips to the expressway system.

The number of lanes needed for each expressway in the system was determined by relating assigned 1975 traffic volumes on each expressway to basic lane-capacity values. Studies of modern expressways have shown that they can be designed to carry approximately 1,500 vehicles with reasonable facility of flow, and can frequently carry sustained hourly loadings approximating 1,800 vehicles per hour.

Lane capacities were translated into average daily capacities through the relationship of peak-hour directional traffic and twenty-four hour daily volumes, and a set of capacity standards was developed for expressways and arterials throughout the metropolitan area. The preliminary expressway system was then viewed in its

Figure 2. Expressway system for the Tulsa Metropolitan Area.

entirety and revised where traffic volumes did not warrant full expressway standards. Traffic assignments were then adjusted to the revised plan and a finalized expressway system was developed.

Expressway System: Proposed expressways for metropolitan Tulsa are shown in Figure 2. Schematically, the proposed expressway system resembles a wheel with its hub being the inner dispersal loop expressway, its spokes the seven radial expressways, and its rim the outer circumferential expressways. These eleven expressways are: Inner Dispersal Loop; Red Fork-Okmulgee-Radial; Riverside-Radial; Osage-Radial; Cherokee-Radial; Keystone-Radial; Crosstown-Radial; Broken Arrow-Radial; Skelly Drive-Circumferential; Sequoia-Circumferential, and Mingo Valley-Crosstown. It was apparent from the 1954 origin-destination study that the dominant traffic movements in the metropolitan area were to and from the central business district, and the "major desire lines" of travel suggested the general location of these radial expressways. The central business district study had revealed that a large percentage of the traffic crossing the downtown cordon area failed to stop in the district. This fact, in addition to the need for inter-connecting the radial expressways, suggested the feasibility of an expressway loop around the central business district. The circumferential facilities serve to link peripheral centers of traffic generation with the residential areas, and provide for crosstown travel between the radial routes.

Other Studies: The following additional studies were initiated after the proposed expressway system had been determined:

1. Right-of-way and construction cost estimates were made for each expressway in the system. Right-of-way costs by the planning commission's special expressway design staff were based on the ratio between assessed valuation and actual sales price. This ratio was then applied to the total assessed value of land required for right-of-way, with provisions for damage or severance and for the relocation of utilities. This method compared favorably with actual appraisal of individual properties.

Construction costs were based on standard highway engineering unit-cost figures for the estimated mileage and number of lanes to be constructed. These figures included all expected features such as overpasses, underpasses, ramps, acceleration and deceleration lanes,

elevated structures, and retaining walls. An additional five percent was included for overhead expenses and ten percent was added for a possible increase in the cost of materials and services. The total cost of the 98.6 mile system over a fifteen-year period, was estimated at $168,195,000.

2. The benefits accruing to users of the expressway system were determined in terms of savings in time and operating costs of motor vehicles. Experience with urban expressways already built across the nation indicated a savings of four and a half cents for each mile driven on an expressway. Accordingly, it was estimated that savings to users of the proposed Tulsa metropolitan area expressway system over the next twenty years would conservatively average $35,000,000 a year; each driver who would travel an average of ten miles each day on the expressway system for one year would save about $165.

3. An analysis was made of the economic effects of certain proposed expressways on selected commercial areas, by the Economic Consultants Real Estate Research Corporation, Chicago, Illinois, and resulted in a report entitled *Analysis of Economic Effects of Proposed Expressway System on Business Thoroughfares*. This study analyzed the variations likely to result in the commercial areas because of new expressways in terms of land values, business volumes, and marketability of business and land.

4. Schematic functional plans were prepared for certain expressways to show how these routes might be designed, and to appraise the feasibility of the recommended expressway routes. This procedure was particularly important in the case of the loop expressway recommended to circumscribe the downtown area.

5. Special studies were made of the inner dispersal loop. The traffic consultants advised the planning commission during the design stages of the Inner Loop and prepared a report entitled, *A Preliminary Analysis of the Central Business District Loop Expressway, Tulsa, Oklahoma*.

A topographic scale model of the inner dispersal loop expressway, as related to the downtown area, was built to present a clear and realistic concept of this complex, yet vital, expressway. So that people in the metropolitan area might see the model, it was exhibited in prominent stores and banks throughout the area. It was also

shown at the Tulsa State Fair and is now on display at the Tulsa Metropolitan Area Planning Commission offices.

Results of Co-operative Expressway Planning

In July, 1957, one month after the completion of the program, the entire expressway system was officially adopted as part of the master plan for the Tulsa metropolitan area by the city, county, and planning commissions. The following August, the three commissions submitted a joint request to the Oklahoma state highway commission asking that the entire system be made a part of the federal aid highway system, and that certain routes be given interstate designation. The entire expressway system was subsequently approved by the Oklahoma state highway department.

In October, the issuance of bonds for expressway right-of-way purchase was overwhelmingly approved by city and county voters. These bond funds, with state and federal aid, will make available $57,500,000 with which to build the first expressway in the metropolitan area's fifteen-year program. Soon after passage of the local bond issues, the state highway department began the development of detailed engineering plans for the entire expressway system.

Contributions and Evaluations: Through a co-operative, interdisciplinary approach, a comprehensive expressway system, correlated with projected land use was developed for the Tulsa metropolitan area. The program accomplished the following:

1. A varied and diversified expressway planning staff brought into focus many views and approaches.

2. Economic, social and planning values were fully considered in relation to highway transportation services.

3. Co-ordination of efforts permitted efficient and concerted expressway planning, and a workable and mutually acceptable expressway system evolved.

4. The co-operative spirit, underlying the entire study, helped secure full public support; it served to stimulate citizen interest and participation.

5. Local financial assistance was promptly attained, thereby assuring early construction, completion and operation of expressways.

Metropolitan Tulsa is not alone in co-operative expressway planning. Even more comprehensive are the metropolitan area transportation studies in many urban areas such as Detroit, Chicago, San Diego, St. Louis, and Washington. The Tulsa study is, however, of particular importance because:

1. It is unique in its co-operative approach to organizational procedures, analyses, and recommendations, and in the subsequent approval of the plan by co-operators and by the public.

2. By prior agreement among the parties concerned, responsibilities were assigned, including the assignment of a project engineer to the study by the Oklahoma department of highways. This permitted concurrent understanding and approval of the various phases of the study at the time they were initiated by all of the co-operators.

3. Throughout the study, initiative and action were undertaken by the Tulsa metropolitan area planning commission. It anticipated the need for basic data and their concurrent analysis for use in both expressway planning and area development; the speed with which the plan was developed was made possible mainly by this factor.

Co-operative Studies for Other Areas: There is need for continuous co-operative urban highway planning studies. In this regard, an adaptation of the basic co-operative approach in Tulsa could lead to successful urban expressway planning programs in other communities. The methods employed should, of course, be adapted to specific local requirements and operate within established administrative jurisdictions. Thus, the organization for a co-operative expressway program may vary considerably from city to city. Co-operation between all concerned with the expressway planning is the basic requisite.

In retrospect—also in *prospect*—integration of highway and urban planning are vital for the well-being of the metropolitan region. They can be best achieved in an atmosphere of co-ordination and co-operation.

Monitoring Traffic Speed and Volume

EDMUND R. RICKER

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ACCURATE recording of vehicular traffic is a necessary element in the operation of a modern toll road because it affects both the collection of tolls and the forecasting of future growth trends that will require expansion of physical facilities. The punched cards used as "tickets," issued to each vehicle on entry and collected on exit, provide complete information on origin and destination of traffic within the system. The customary tabulation of these data for accounting purposes is usually performed daily and is limited to:

1. Total exits, by class, at each interchange, from each other interchange;
2. Total exits, by class, at each interchange;
3. Total entries, by class, at each interchange, destined for each other interchange;
4. Total entries, by class, at each interchange;
5. Grand totals of exits, entries and vehicle miles traveled;
6. Corollary data on tolls collected.

Similar data are tabulated on a summary basis, weekly, monthly and annually.

Except for terminal toll plazas, these data do not relate directly to the usual traffic engineering concept of volume, i.e. the number of vehicles passing a point. This information can be obtained, however, by arithmetically combining the origin and destination information provided for each point of entry and exit.

Appropriate tabulation of entry and exit data by direction also indicates the total volume on each ramp *inside* the toll plaza. For each class of vehicles, or grouping of classes such as trucks, separate

analyses provide volume between interchanges or other interesting information—whether truck volume is equal for both directions of travel, for example.

Although each toll ticket is time-stamped on entry and exit, this information is not usually punched into the cards, and analyses made therefrom are extremely time-consuming. (They also may be widely inaccurate because of intermediate stops at service areas.) At each toll plaza, data are available on recorder tapes, indicating the number of axles passing over the treadles of each lane per hour, and the number of "transactions"—the number of tickets time-stamped. The latter may be assumed to equal the number of vehicles handled on exit, but the practice of pre-stamping entry tickets in anticipation of rush periods makes the entry data of little value.

Although analysis is time-consuming, recorder tapes do provide useful hourly data for computing hourly flows through particular interchanges, and at terminal interchanges they indicate the hourly distribution of volume, at least in the exiting direction. They do not reflect short-term fluctuations and do not indicate time-volume over the approach roadway when traffic is backed up at the plaza and not free-flowing.

Concurrent with the opening of the New Jersey Turnpike to traffic, efforts were made to obtain additional volume data by conventional means. These efforts were increased as traffic rose rapidly to levels not anticipated for fifteen years hence, and periods of congestion indicated an early need for expansion of both roadway and toll collection facilities. Conventional traffic counters, using pneumatic tubes across the traveled lanes were found completely inadequate, both because of the difficulties of keeping the tubes in place and because accurate counts of the high-volume high-speed traffic could not be obtained.

Electric eye types were not suitable because of the multi-lane flow. Manual counts were reasonably accurate but expensive in manpower, and it was found difficult to anticipate peaks so as to have personnel available for counting. (The heaviest traffic between the opening in November 1951 and July 3, 1953, was on February 24, 1952, the Sunday of a three-day Washington's Birthday week-end.)

Experience with manual counts showed that speed was an important consideration in determining the rates of flow obtained without congestion. For example, moderate flows might be noted, at a rate of say 2,600 an hour in two lanes under free-flowing conditions; shortly thereafter, congestion might develop and all traffic come to a stop-and-go condition, with little countable volume. Another important need was the distinguishing of volume and speed in each lane, rather than a total of all lanes.

The collection of speed-volume data cannot be an end in itself, and the development of more sophisticated equipment, or expenditures therefor, must be based on the values of such data in day-to-day operations or long-range planning. The principal advantage that could be forecast was in determining the relationship between speed and volume at the point where capacity is exceeded and free-flowing conditions cease to exist; closely related is the recording of all volumes to determine the frequency of near-capacity conditions so that additional capacity may be provided before congestion becomes a frequent occurrence.

It was also anticipated that the regular recording and noting of flow conditions might be useful in guiding operating procedures, such as the assignment of police manpower or the posting of alternate routes. The Turnpike Authority was convinced of the potential values in such research, and set aside an appropriation in its 1957 Capital Budget for the development and purchase of suitable equipment.

Meanwhile, work was proceeding on a device to record speed and volume, and members of the Turnpike staff were frequently consulted as to the form in which the data could be most usefully presented. Experimental models had been tested on the Merritt Parkway and the California Freeways in 1956. Equipment to cover three lanes was ordered in April 1957, and placed in operation on August 20, 1957. It was designated as the Electro-Matic Traffic Monitor, and the Turnpike Authority is proud to have the first complete installation of this new and important traffic engineering equipment.

The Traffic Monitor

The traffic monitor consists of individual units for each roadway lane to be surveyed, the essential elements being a radar sensing

unit which is mounted directly over the lane and a rack of electronic analysis equipment which may be located at any convenient point where it may be sheltered and available for observation. A communication link, such as a two-wire telephone circuit, transmits information from the sensing unit to the analyzing equipment. Individual units may be combined to study adjacent lanes or widely scattered points along the roadway. Permanent records may be obtained with suitable recording equipment.

The radar sensing unit is similar in appearance to radar detectors used for traffic signal control; it is housed in a cylindrical container twelve inches in diameter, and fourteen and one half inches high and is supported by a slip-fitting connected to a two-inch pipe support. It is designed for mounting about sixteen feet above the pavement and centered over the lane. The sensing unit is easily removed from the housing. Power and output connections are made through a quick-disconnect plug. The power consumption is thirty watts, operating on 115 volts AC; the output circuit operates between 10 and 1,000 cycles, adjusted by a sensitivity control to 1.5 volts. The antenna is pointed about forty-five degrees from the vertical in the direction of traffic, and emits a signal at 2,455 megacycles. Operating on the Doppler principle, it detects the passage of a vehicle within that lane, and measures the speed of any vehicle within the radio beam. This information is presented as a wave train of AC voltage that may be amplified and transmitted to the analyzing equipment.

At the point of installation a suitable supporting structure must be available, as well as an AC power supply and connections to a communication system, such as public telephone lines. These requirements, together with the desirability of being inconspicuous to drivers, make it convenient to mount the sending units on the side of an overhead highway structure away from traffic, which also provides easy access for maintenance. No other equipment is required at the field site except the sensing unit, suitable watertight boxes for connections and the sensitivity control, which may be mounted near ground level. The Turnpike installation is shown in Figures 1 and 2.

The analyzing equipment is mounted in a vertical rack and consists of four sections: a speed and impulse translator, a speed averaging computer, a volume computer and a volume classifica-

tion unit. The useful information derived from this equipment is: 1. The speed of each vehicle. 2. The average speed of the preceding group of "n" vehicles. 3. An indication of the movement of each vehicle in the lane. 4. A count of the number of vehicles during the preceding time "t." 5. A measurement of the elapsed time at which traffic has been moving in each of six volume ranges.

The signal received via the communication line from the sensing unit consists of two parts. When heard on a set of headphones, the first is a low-pitched "bump," indicating the movement of a vehicle in that lane; the second is a higher "woo-ooo," the pitch being proportional to the speed. When a vehicle passes through the field of the sensing unit, but not in the lane, only the second tone is heard.

The purpose of the speed and impulse translator is to convert the first portion of the signal to a countable output and the second portion to a speed measurement. If the first, or counting, signal is missing, the speed measurement is not passed on to the other components, although it will show on the speed meter. The speed measurement circuits are similar to those in the conventional radar speed meter and each speed reading is momentarily presented on a dial on the face of the unit. The passage of a vehicle is noted by a short duration flash on an indicator light. Adjustments of the speed zone and detector zone may be made by knobs on the face of the unit.

The speed-averaging computer receives individual speed readings, stores each temporarily on a "last car" circuit, then computes the average speed of the last "n" cars passing through that lane. The "last car" speed is shown visually to facilitate adjustments and reading of individual speeds. The "average" speed is actually the root-mean-square of the speed of the last "n" vehicles. The root-mean-square (RMS) of speed has a mathematical and particularly important electrical engineering connotation.

The RMS may be defined as the speed of "n" vehicles, obtained by squaring the speed of each vehicle, dividing the sum of the squares by "n" and extracting the square root. As first installed "n" could be set at six values between 20 and 100. These values proved to be too large to properly reflect changes in speed, and the range was subsequently changed to values between five and thirty. A second meter indicates the current value of the average speed (RMS). Adjustment of the last car meter to match the speed reading

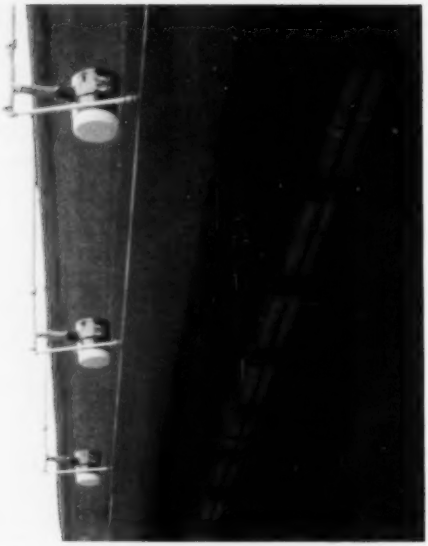


Figure 1.

Figure 2.

Side and front views of installation over southbound roadways of the New Jersey Turnpike.

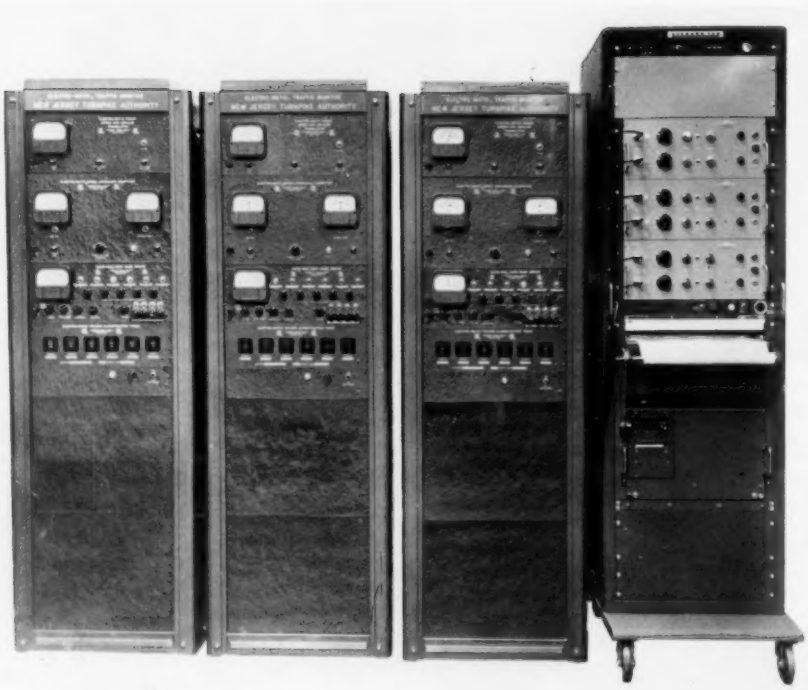


Figure 3. Monitoring Equipment.

and a null set are made by knobs protruding from the front of the unit.

The volume computer is similar to the cycle computer used in many modern traffic signal installations. Its function is to measure the rate at which the vehicle-counting signals are received. Measurements are made in percentages of a pre-selected volume per lane, which may range from 800 to 2,400 vehicles per lane in a continuous scale. The volume is continuously computed over the time interval "t," which may be adjusted by the response time dial over values from one to seven minutes.

Thus, the indicated volume may be thought of as a running hourly rate, based on the preceding "t" minutes. This information is presented visually on a scale graduated from 0 to 100 percent. The 100 percent volume range may be divided into six parts, the division points being selected by appropriate settings on five dials which are likewise graduated in percentages. Operation within a particular range is shown by an indicator light corresponding to that range.

The volume classification unit consists of six elapsed time meters calibrated to hours and tenths of an hour, with a maximum reading of 9999.9. Each is connected to one of the six volume ranges of the volume computer. Only one meter is in operation at any instant, recording the elapsed time that traffic has been moving in that particular volume range. Periodic visual readings of all meters indicate the time of operation in each volume range.

While the volume and speed data may be recorded in several ways, it is convenient to use a Sanborn Recorder, which combines direct current amplifiers and sensitive galvanometers to record six variables simultaneously. In this machine, a heated stylus moves over sensitized paper which is driven by an electric motor over a knife-edged platen. The resulting trace can be adjusted to a fine line and is presented in true rectilinear co-ordinates, since it is obtained by contact between the arm and the platen, rather than by a pointer which swings with the arm across the paper.

The rectilinear co-ordinates allow measurement of total volume within any time interval by simply planimetering the area under the curve. The sensitized paper is fifteen inches wide and 200 feet long, and is ruled in six longitudinal sections, each five cm. wide.

Co-ordinates are ruled at one mm. intervals, with a heavier grid at five mm. intervals. Paper speeds can be adjusted from 0.75 to 300 mm. per hour. An automatic timer marks the paper at hourly intervals. Readings can be made within the accuracy of the other monitor components.

The Study Site

The first location selected for study on the New Jersey Turnpike was at Milepost 97, in the City of Linden. It meets most of the physical requirements—a straight alignment, nearly level grades, is remote from interchanges or other weaving areas, and there is an overhead highway structure carrying both electric power and telephone lines. More important, this section of the Turnpike experiences the highest daily volumes during the summer months and congestion had previously occurred there during peak periods. Specifically, the site may be described as follows:

Location: Between Interchanges No. 12 and No. 13 at Milepost 97.2.

Alignment: On 10,300 foot tangent, 6,300 feet beyond the south end of the tangent.

Grade: –0.5 percent at study site. To the north there is no grade above 1 percent for over a mile; to the south the nearest higher grade is on a rise about 0.65 mile away.

Interchanges: 2.8 miles to north, 1.2 miles to south. Neither interchange carries extremely heavy volumes during peak hours.

Cross Section: Six 12 foot lanes, separated by an 80 foot median with 5 foot inner shoulders and 10 foot outer shoulders.

AADT 1957: 21,279 Northbound
21,502 Southbound.

The sensing units were first placed to study northbound traffic, and transferred to the southbound lanes on July 2, 1958. Over the northbound lanes they were attached between adjacent girders, but this proved unsuitable for maintenance, and the later installation is made outside the facia girder where a bosun's chair was used for access. Some problems were caused by vibration due to heavy trucks on the bridge, and the shock mounts had to be altered in the sensing units. Three pairs of commercial telephone wires are rented, connecting to the Authority's Administration Building, thirteen miles to the south.

A small administration-building office, adjacent to the traffic engineering department, is set aside for the monitoring equipment. (See Figure 3) The three racks are placed side by side and connected in the same relative position as the lanes being observed. AC power is obtained from a wall outlet, and telephone connections are made through floor ducts.

Operation of the Monitor

After experimenting with various settings, the equipment is now operated under the following conditions:

1. Number of cars for which speed is averaged (n)—10.
2. Volume per lane at 100 percent reading—2000.
3. Period over which volume is measured (t)—six minutes.
4. The range selectors set at 30–40–50–60–70 percent, corresponding to volumes of 0 to 600, 600–800, 800–1000, 1000–1200, 1200–1400, and over 1400 vehicles an hour.
5. Regular readings of elapsed time meters, every twenty-four hours, at 2 P.M.
6. Speed of paper in recorder, 75 mm. an hour.
7. These settings result in each channel on the paper having a full-scale capacity of 100 miles an hour, two mph for each one mm. graduation, or 2000 vehicles an hour, forty vph for each graduation. The five mm. time graduations appear every four minutes.

Data Collected

During the first nine months that the monitor was in operation, traffic was seasonably low and no important peak volumes were observed. The time was well used in obtaining experience in proper settings of the monitor controls and in getting minor adjustments made in the equipment. In addition, knowledge was gained on several operating problems, which may be illustrated by the following:

Reduced Speed Limit During Snowstorms: For several years it has been the practice of the Turnpike Authority to reduce the speed limit from sixty to thirty-five miles per hour during severe inclement weather, such as snowstorms or heavy fog. The state police are responsible for determining at what time the speed limit should be changed, since their patrols are active in all areas at all times of day

or night. However, there were no factual means of determining when this step was necessary, and the judgment of individual troopers was found to vary widely, particularly as to when conditions had improved enough to justify a resumption of the normal sixty mph limit.

It was recognized that a too-long continuance of the thirty-five mph limit after conditions had improved would not only reduce its effectiveness on future occasions, but also make "violators" out of a majority of motorists. During the severe snow storms of the past winter, the monitor gave a very reliable indication of the time for changing the speed limit in that particular area, and in fact, was used for that purpose. On several occasions it was noted that the RMS speed was near thirty-five mph prior to the time that troopers requested that the limit be reduced, and conversely the RMS speed rose to the vicinity of fifty mph as conditions improved, regardless of the posted limit. Further application of this principle can be readily imagined, possibly with automatic control of the speed limits corresponding to the change in speed of the majority of traffic.

Keep Right Except to Pass: As multi-lane roads have been constructed, the Keep-Right rule has come up for discussion. Some administrators—and motorists—feel that all traffic should normally travel in the extreme right lane, only entering the left lanes to pass other slow-moving vehicles and then returning to the right lane. Others believe that all lanes should be used to realize the capacity of the roadway. In general, trucks and other slow-moving vehicles travel in the right lane, while passenger car drivers avoid this lane in order to maintain speed. Occasionally slow-moving vehicles travel in the left lanes, delaying traffic, causing others to pass on the right, and raising demands for stricter enforcement of the "Keep Right" rule. The records of the traffic monitor are quite interesting in this regard, as they seem to indicate that motorists are using the various lanes in a reasonable pattern. This is illustrated in Figure 4. The right lane is used almost exclusively at low volumes, and as more traffic develops, the center lane carries the heavier load.

The volume in the left lane does not increase as rapidly as that in the center, thus leaving it open for passing. At volumes approaching capacity, the left and center lanes carry almost equal numbers of vehicles. Similarly, the speeds observed in the several lanes reflect

a differential which facilitates normal passing on the left, three typical RMS readings being: left lane sixty-one mph, center lane fifty-eight mph, right lane fifty-four mph. Thus, while enforcement is needed to keep slow vehicles from obstructing traffic, there does not appear to be a need for greater emphasis on "Keep Right."

Capacity Measurements

During the summer of 1958, one-directional traffic past the monitor site has reached a rate of about 4500 vehicles per hour for short periods. On one occasion, when volumes had exceeded 4000 vph for several hours and then increased to a peak of about 4400 vph,

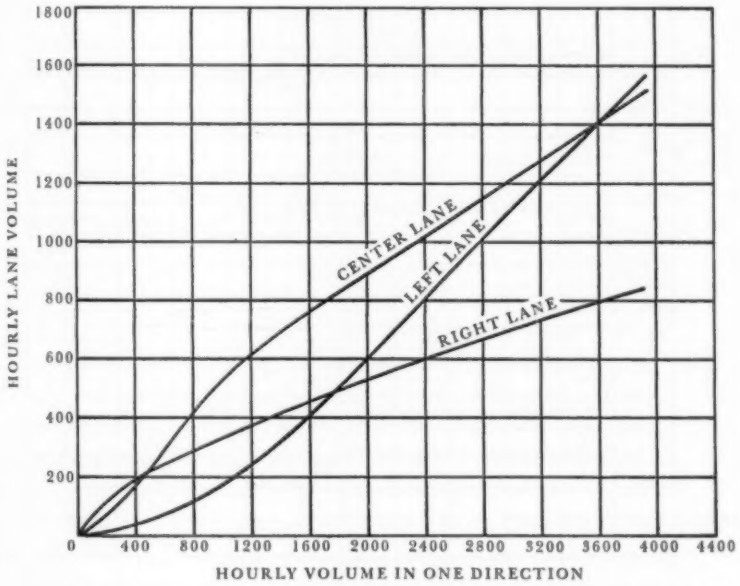


Figure 4. Typical distribution of vehicles by traffic lanes.

congestion was observed. This occurred on June 1, the Sunday of the Memorial Day weekend. During this twenty-four hour period there were 139,028 vehicles on the Turnpike. Of these, 71,733 vehicles traversed the area between Interchanges 12 and 13, and 44,338 were northbound between these Interchanges. Records

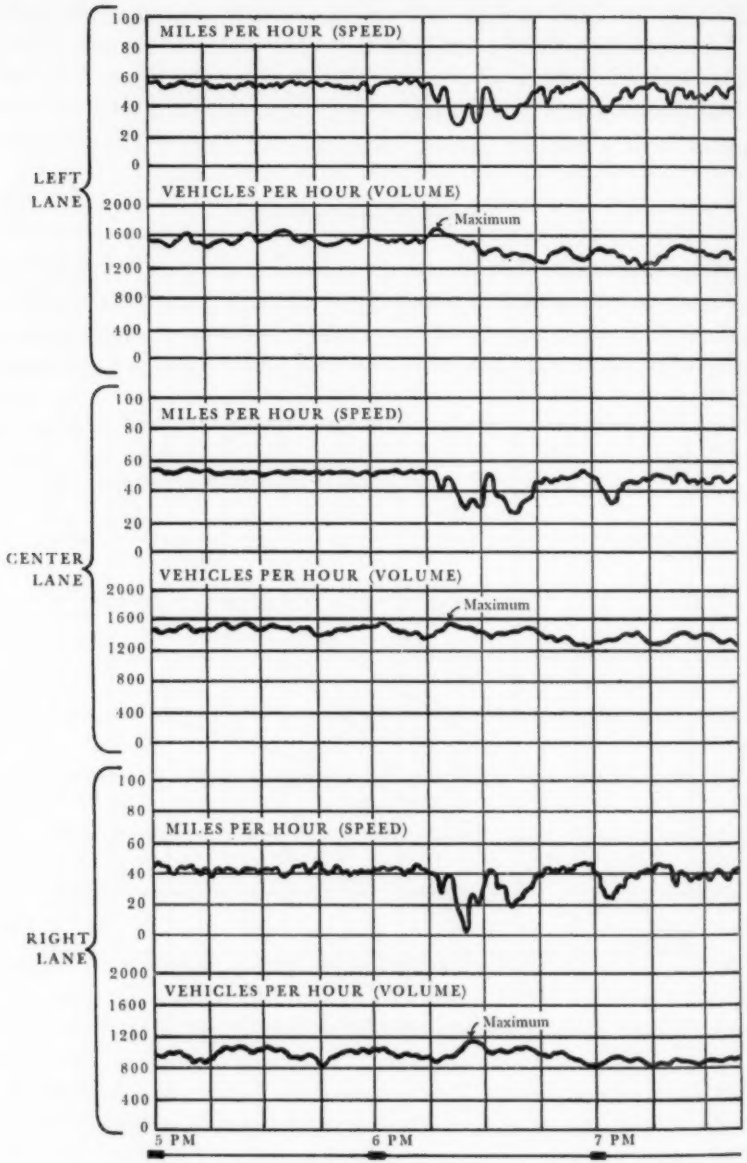


Figure 5. Monitor recording for a peak traffic period.

indicate that this northbound volume was the maximum daily volume recorded through this area.

Traffic was heavy throughout the entire afternoon and evening, reaching a peak about 6 P.M. At this time the speed in the left lane was about sixty mph, the center lane about fifty-two mph, and the right lane about forty-four mph. Around 6:15 P.M. traffic suddenly slowed down almost to a stop-and-go condition, although there were no accidents or disabled vehicles in the area. This condition is characteristic of overloading past capacity. The speed break was accurately reflected in the records of the traffic monitor, a photostat of which is shown in Figure 5. The peak instantaneous volume recorded was 4,160 vehicles per hour. Although there was not a tremendous drop in volume when the speed broke, traffic was mov-

Table I

VOLUME NORTHBOUND AT MP 97, JUNE 1, 1958

Hour Ending	*Left Lane*	*Center Lane*	*Right Lane*	*3-Lane Totals*	*Approximate Hourly Average Speed*		
					Left	*Center*	*Right*
0100	120	380	320	820	62	57	46
0200	70	300	240	610	61	59	47
0300	50	220	200	470	60	60	48
0400	40	150	160	350	60	58	48
0500	30	100	110	240	61	59	48
0600	30	90	150	270	62	60	50
0700	25	80	140	245	62	60	52
0800	35	120	200	355	62	60	52
0900	30	200	260	490	62	61	52
1000	50	340	340	730	62	60	50
1100	150	550	400	1100	62	59	48
1200	320	780	510	1610	62	58	47
1300	520	900	520	1940	61	57	47
1400	660	1000	610	2270	61	56	46
1500	970	1090	680	2740	60	56	46
1600	1280	1300	780	3360	60	55	46
1700	1520	1400	890	3810	58	54	44
1800	1560	1500	960	4020	55	52	43
1900	1490	1440	960	3890	49	45	38
2000	1380	1320	860	3560	53	48	41
2100	1230	1170	780	3180	58	52	45
2200	1040	1130	720	2890	60	53	45
2300	900	1000	610	2510	61	53	47
2400	680	910	520	2110	62	55	48
Total	14,180	17,470	11,920	43,570			

ing in a hazardous manner due to the need for reducing speed upon approaching the congested area and conditions were not typical of good Turnpike travel.

A detailed analysis of the monitor charts for this day was made and the hourly volume totals for each lane measured from them are shown in Table I. It will be noted that the total volume for the day does not exactly agree with the total obtained from toll tickets. The difference is less than two percent, and may well be accounted for by the large difference in vehicles on the Turnpike at midnight Saturday as compared to midnight Sunday. Since the tickets are not all deposited simultaneously, and cannot reflect vehicles in transit at the time of deposit, it is quite possible that the monitor count is more accurate. (Direct comparison of manual counts to those obtained from the monitor during six minute intervals have been found to agree very closely.)

The peak instantaneous volumes, measured over six minute periods, on June 1, are shown in Table II, together with the corresponding speeds.

Table II

	L. Lane Peaked	*C. Lane Peaked*	*R. Lane Peaked*	*Avg. Speed Range During 8 Min. Period*
Volume Left Lane	1710	1660	1510	56 to 27 mph
Volume Center Lane	1470	1570	1500	48 to 28 mph
Volume Right Lane	890	930	1130	39 to 1 mph
Total	4070	4160	4140	
Time of Occurrence	6:19 P.M.	6:22 P.M.	6:27 P.M.	Between 6:19 P.M. and 6:27 P.M.

From these it may be noted that the left hand lane carried the highest volume, but analyses of the detailed graphs indicated that the left lane started to decrease in volume while the right lane was still increasing.

Data such as this represent the principal value of the traffic monitor. When additional peaks are observed so that average values are obtained, it will be possible to state accurately the capacity of the Turnpike in terms of existing traffic flows, as well as to predict the frequency with which congestion will occur under existing roadway conditions.

Lansing's One-Way Street System

ALLEN T. HAYES

Mr. Hayes has been City Traffic Engineer for Lansing, Michigan since 1951. Previously, he was Transportation Inspector for Norfolk, Virginia. Mr. Hayes also worked for five years in the passenger traffic department and general offices of the Seaboard Railroad, Norfolk, Virginia. He has attended traffic engineering seminars at Yale and Northwestern Universities.

CAPITAL cities present many problems, usually because of the location of the capitol building. This location, combined with natural and man-made barriers, sets the traffic pattern. It is not possible to say that a city fits Plan A, Plan B, or any other plan. Each city has its own traffic characteristics. Lansing, with 100,000 population, is no exception.

The direction of traffic on the one-way street system proposed for Lansing could have been decided by the flip of a coin—heads, clockwise; tails, counter-clockwise around the capitol building. However, it was not decided this way. The factors involved in both plans were weighed, and the final decision was based on these findings.

Upon my arrival in 1951 as the new city traffic engineer, Lansing offered a fertile field. Original one-way street proposals had met opposition. Influential opposition had invaded the thinking of some members of the traffic commission, but development of plans for one-way streets in Lansing continued. There were no restrictions on dissemination of one-way street propaganda.

A year of occasional work produced a plan that seemed desirable and beneficial. Public opinion, goaded by the delays and irritations of stop-and-go driving, rose to the breaking point. Traffic commission opposition gradually disappeared, and the original plan, with some suggested revision, was recommended to the city council for consideration.

Because it was a major change in the long-established habits of the citizens and because of opposition to the plan, the city council set a public hearing date to discuss the pros and cons. Anyone familiar with public hearings appreciates that opposition is usually

well organized. In the public hearing, contrary to tradition, proponents and opponents were present in about equal proportion, but those in favor were more vociferous and forceful than those opposed.

The city council approved the recommended one-way plan, and set the date for its inauguration—Sunday, March 22, 1953—on a ninety-day trial basis under ordinance.

Formulating the Plan

Planning the one-way system was difficult. Gathering of information was confined to basic facts because of the lack of manpower and equipment. Shortcomings of the traffic signal system under two-way operation were obvious. The alternate signal system on all two-way streets limited overall speeds to a maximum of ten to twelve miles an hour. Stop-and-go driving was the rule.

Automatic traffic counters were used to record traffic volumes on the proposed one-way streets. Volumes on the north-south one-way pair—Capitol and Grand—were about equal. Washington Avenue, the main street of Lansing, was the shopping-parking street. Volumes on the east-west streets were found to be well divided.

Determining Direction of Traffic

The capitol building's location was the principal factor in determining whether traffic movement should be clockwise or counterclockwise around the capitol.

Grand River as a natural barrier was also a determining factor. Storage of vehicles from the east on the bridge streets was critical. Traffic from the east, confined to four bridge streets entering the central business district was heavy. This traffic encountered difficulties entering the downtown area on Michigan Avenue because of the method of parking and the inadequacy of CBD two-way streets to handle high volumes of traffic efficiently.

To divert this traffic across Washington Avenue to Capitol Avenue with consequent blocking of Washington Avenue was not advisable. Congestion was critical without this addition. Storage of vehicles was a problem on the other three bridge streets.

The dilemma was avoided by making Grand Avenue south-

bound and Capitol Avenue northbound. This decision was challenged by the pattern of traffic from the south, most of which used Washington Avenue. It was determined that about fifty percent of this northbound traffic used three streets—St. Joseph, Hillsdale, and Lenawee—to reach Capitol Avenue to enter the CBD. While it was contrary to conventional flow, it did not outweigh the traffic-from-the-east problem.

The desire of shoppers was to park on the main street, preferably in front of the store to which they were destined. To make it very difficult to get on Washington Avenue was not acceptable. "Main" business area trend was southward, with most of the business establishments south of Ionia Street. To further complicate matters, all left turns at seven Washington Avenue intersections were prohibited. To accomplish desired results the proposed one-way system seemed essential.

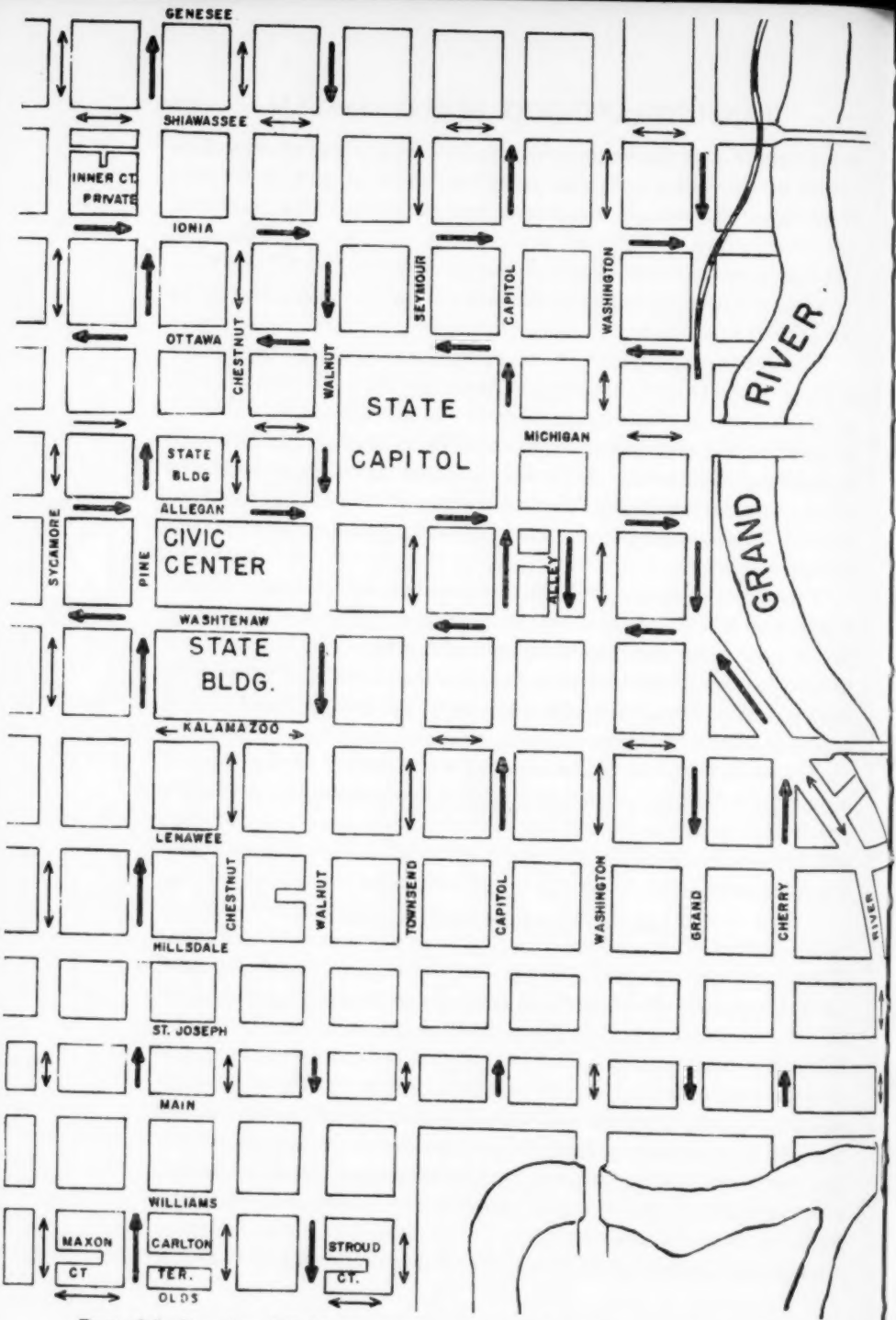
The effect of the capitol location and the main streets—Washington and Michigan Avenues—is apparent. North-south one-way streets that carry the largest volume of traffic are separated by a two-way street. East-west one-way streets are parallel pairs, with each pair separated by a two-way street. All bridge streets are of necessity two-way streets.

To avoid criticism of the one-way street system as the cause of normal post-Easter business decline, it was necessary to start before Easter. Easter is the second heaviest shopping season of the year, and Spring is a good time to begin something new. Palm Sunday was selected.

Efficient Signal System Essential

The success of a one-way street system depends substantially upon the traffic signal system. Nothing is more exasperating to the motorist, who is anticipating the benefits of a new system, than to be delayed by signals that do not permit progressive movement. This does not mean that it was possible to provide perfect signal progression in all directions, but progression was achieved on the heavily traveled north-south streets and on some of the east-west streets. Considerable time was spent in perfecting a system that would provide desirable progression on one-way streets without penalizing traffic on two-way streets.

The downtown signal system was fairly modern. For two-way



Part of the Lansing, Michigan, one-way street system encompassing the district in which are situated the State Capitol, the Civic Center, and the State Building.

operation, corner pedestal-mounted signals were located at far right and far left, with standard three-color indication. All CBD signals were inter-connected and supervised by a master controller, but not all intersections had independent local control.

Previously, a fifty-second cycle was in use with single alternate operation. This gave a possible speed of twelve and a half miles per hour, with stop-and-go driving. During peak periods, speed was reduced to walking pace. In many blocks one could walk faster than vehicles moved; constant congestion and delay were inevitable. Point control by traffic officers was necessary at many intersections.

Of the twenty CBD signals, eleven had single-dial controllers; seven had three-dial controllers; two were operated from the master cam to a local cascade relay box.

Fortunately, enough signal changes could be made to set up the desired operation for the one-way system. A quarter-cycle off-set was used to give nearly perfect progression on one-way Grand Avenue and Capitol Avenue with double alternate on Washington Avenue. Intersection splits were determined by estimating volumes on the east-west streets.

The off-sets were also estimated to compensate for difference in block lengths and heavy feeder streets. This was necessary at the start of the one-way operation as there was no way of telling what the volumes would be. Lack of manpower after the system's inauguration made impossible any manual intersection-volume counts; so splits and off-sets had to be adjusted from observation of traffic flow. The quarter-cycle off-set gave a north-south theoretical speed of 28.6 mph.

Not all traffic signals were in operation at the start of the one-way system. One new signal had to be installed at Grand Avenue and Washtenaw–River Streets. Walnut Street, formerly a quiet secondary street, became an important southbound street. Signals planned for five intersections were not installed as promptly as desired, but as expeditiously as possible; two were installed in April, one in May, and two in September. These were overhead installations with double indication. Signals were co-ordinated with CBD signals and those existing to the west with single alternate operation.

Signals on Pine Street were overhead with single indication and co-ordinated with single alternate operation. On Logan Street, signals were installed and operated the same as on Pine Street.

These well-placed signals fit into the fifty-second cycle system. It was soon obvious that fifty-second cycle, single dial control was not adequate for peak-hour volumes in the one-way system. A city-wide modernization program was launched with emphasis on central business district signals. The aim was to modernize the signal system, with all vehicular signals overhead and, where needed, corner-mounted pedestrian signals, and interconnection for predetermined signal systems.

With increased capacity and a progressive signal system, even though confined to a fifty-second cycle, results were favorable and public acceptance was immediate.

Signs Installed to Direct Traffic

Importance of the intersection and the location of street lights in relation to signs (Lansing has boulevard lighting on all streets) determined whether or not one-way signs would be reflectorized. TWO-WAY TRAFFIC AHEAD, DO NOT ENTER, NO LEFT TURN, NO RIGHT TURN, NO TURNS sign-locations were spotted. Temporary barricades and pedestal signs were prepared for use where needed. Two hundred and forty-four one-way signs and forty other related signs were used.

Permanent signs were erected during the three weeks preceding the start of operation and were covered with paper. Regular inspection was necessary to make certain that signs were not uncovered until the proper time.

ONE-WAY signs were placed to provide near-right and far-left observation. At major intersections, ONE-WAY signs were placed near-right and left and far-right and left, with DO NOT ENTER signs on the exit leg of the one-way streets to give emphasis. Turn prohibition signs were placed at major intersections to augment the ONE-WAY signs.

Placing the System in Operation

Public information concerning the one-way plan was excellent. Newspaper, radio, and TV co-operated to inform the public. The *Lansing State Journal* carried the bulk of the news items. These were prepared daily for a month in advance of the beginning of the

one-way operation. A one-way street map was printed twice in the paper. The Lansing Safety Council teamed with the Traffic Commission to print a pamphlet containing pertinent points about the one-way operation and a map of the system. These pamphlets were widely distributed to the public.

On Palm Sunday, sign crews were out early uncovering signs, signal crews made necessary changes, and the police were ready. The Sunday paper had a composite picture on the front page showing a disarray of signs pertaining to the one-way operation, with a bewildered family in their car.

To everyone's surprise, traffic moved smoothly over the new one-way streets. Churchgoers got to church and home again. After church the curious came out to ride the one-ways. Monday and the days following came and went with no more trouble than the usual troubles of drivers adjusting to a new system.

The most prevalent remark was how much sooner people got home from work—minutes saved in travel time, vital minutes to all. The most prevalent complaint was that Capitol Avenue and Pine Street northbound under one-way operation were "race-ways." This was true in some isolated instances where the new freedom of movement was exploited. However, when the possible speed is more than doubled and the vehicles keep moving, an illusion of excessive speed is created, even though it averages only twenty-five miles per hour. Time and some concentrated enforcement soon eliminated these complaints.

Other complaints were minor or incidental. Hotel patrons found their way to the hotel; motorists found convenient ways to reach gasoline facilities and parking lots on the left side of one-way streets. Some parking meters had to be relocated.

Two orthodox and one unorthodox pedestrian controls were placed in effect to expedite heavy turning movements by eliminating the vehicle-pedestrian conflict. Two were full-time pedestrian crossing prohibitions; the other was effective from 5:00 to 5:30 P.M., Monday through Friday. The latter is handled by the police and involves putting a chain across the crosswalk during the prohibited period. Pedestrian observance is excellent though it greatly inconveniences some pedestrians. Vehicle-turning volume is 100 percent greater without the pedestrian conflict.

The vehicular accident rate increased as expected but soon

settled down. Left turns from wrong lanes caused the most accidents. Islands were installed at some CBD heavy turn intersections—in four locations to force right turns and in one location to force left turns. Multiple turns were encouraged at heavy turn intersections but were difficult to get motorists to accept .Two "cruising blocks" became problems almost immediately with motorists cruising the blocks north and south of Capitol, Washington and Grand Avenues, searching for a parking space on Washington Avenue.

Soon after the operation began, motorists going west on Washtenaw Street and Ottawa Street found they were driving on the wrong side of the street after crossing Logan Street, the terminus of the westbound one-ways. After sixty days, the westbound one-ways were extended to their terminus. There was no opposition to this extension.

The ninety-day trial period ended without a word of criticism—actually, it passed unnoticed.

Lansing had accepted one-way streets in full stride. Public opinion in favor of one-way streets was overwhelming. It was a traffic turning point in Lansing.

Parking Comes of Age

ALLAN H. ROGERS

Mr. Rogers is on terminal leave as Director of Public Works, Garden City, N.Y., where he has been an official since 1930. From 1934 to 1958 he served as Superintendent of Public Works and Village Engineer, and was in direct charge of all planning, construction, and operation of the parking program. He is a past president of the American Public Works Association, a member of the Institute of Traffic Engineers, and a licensed professional engineer.

IN the twenty-one years of off-street parking in Garden City, Long Island, the mistakes, progress, and changes in planning and design can be usefully examined.

When Garden City, a suburban community of 9,700 population in 1951, began its off-street parking project, there was little proved practice to guide it. It was a pioneer in the field, and much of its theory and design was its own. Today, with its population at 23,000 —drawing also from a considerably larger trade area—many of our ideas have been adopted in other communities.

Garden City's original plan was described in the April 1947 issue of *Traffic Quarterly*. Basically our theory was that parking was a *public* responsibility; that adequate parking should be adjacent to contributory business and apartment properties; that the cost of acquiring necessary land should be assessed against the traffic generators; that improvements should be at village expense, and in a well-regulated manner—ease of parking, provision for snow disposal, diminution of traffic impact, ornamental landscaping, and screening to prevent deterioration of adjacent residential property.

The first stage, in 1937, began with six parking fields having a capacity of 733 cars. This sufficed for a short period, as more business sought the advantages. In the July 1954 issue of *Traffic Quarterly*, we reported an aggregate capacity of 1,951 cars in facilities at the rear of or adjacent to every business establishment, with 269 car stalls under construction, and no basic change in policy.

In the twenty-one years of our parking program, Garden City

and the surrounding area have experienced an unprecedented growth. With some reserve property always available, we have provided additional facilities as business demanded them. By other methods, additional parking areas have been donated or reserved. While we have made *minor* changes in our original thinking, *basic* policies hold and more than adequate parking under normal conditions obtains.

Despite stall widening, we have off-street parking for 4,117 cars in sixteen fields. Property has been acquired for three more fields—about 545 more cars, and negotiations are in progress for other areas to meet present demand and future need.

There has been no change in our basic thinking about the cost of acquisition and improvement of these parking areas, except that in some instances where unanticipated loading is considered, we believe the improvement cost should be borne by the generating agency. We have deeds to both vacant and improved property for parking areas, provided we make the improvements.

Minor Changes in Design

There have been minor design problems. Where in the past we have used six-to-seven-foot medial sidewalks to separate parking zones, we have in recent large fields eliminated these and used painted stall lines, in the interest of snow removal and maximum capacity. There is conflicting opinion on design detail, but we continue to believe that if space and other conditions permit, the medial sidewalk permitting planting and car separation is desirable. Actually, our medial sidewalks, not designed primarily for pedestrian use, generally run parallel to the business properties instead of feeder walks. Yet we find that parking against a curb is more orderly than over painted lines, and that trees in these areas, in parking fields near residential sections, enhance the appearance.

We are increasing the radii of entrances. Originally these were kept at a minimum to discourage cruising between fields and short-cutting traffic signals, but the advantage of accommodating delivery and of servicing trucks at the rear of stores dictated a change that permits easier entrance and exit during peak-hour traffic. Another device to discourage cruising is a five-foot (or more) pedestrian

walk between the parking field and the street. Once conveniently parked, it is easier to walk to the street and across than to seek another parking spot.

All fields have been posted with signs to the effect that the village will not be liable for loss or damage to cars or contents. Whether this posting is necessary may be questioned. However, about midway in the parking program, and based largely on street experience with public liability claims, all parking fields are covered by insurance calculated on a square-foot basis. Our experience on infield motor vehicle and personal injury accidents has been favorable.

Our 1956 revision of the zoning ordinance was based upon parking. No building permit can be issued for multi-family dwellings except on a parking-space-per-family formula; no permit can be issued for commercial or business uses except on a finding by the board of trustees that "the parking space is adequate in amount and satisfactory as to location and design." This determination is made on the facts in each individual case, as no rule-of-thumb formula seems satisfactory. It may have delayed some building operations, but it has produced other parking facilities and has not impeded the overall program.

Time Limited in Some Parking Areas

The original plan was that there would be no attendants, parking meters, or time-limit restrictions in any parking field. We have no attendants and no parking meters, but certain time restrictions on parking have recently been imposed in parts of certain fields. Employees were pre-empting the most desirable parking spaces behind stores (and generally not their own stores), and otherwise overloading parking facilities to the detriment of shoppers and patrons.

Accordingly, in certain fields, three-hour restrictions were imposed, forcing the all-day parking into more remote areas of these fields or into other fields with available space. This was particularly effective in the vicinity of super-markets and neighborhood shopping stores, to the extent that turnover was substantially increased and the chamber of commerce is now recommending expansion of the time-limit feature, i.e., the customer gets preferential parking.

The three-hour limit was selected after conferences with the chamber of commerce and other business interests to develop the most satisfactory time for a change that, to some, seemed major in policy. There were several reasons for this particular time selection. One-hour or two-hour time would have sufficed in most cases for general shopping and business transactions, but would have required more frequent police check. Four-hour parking permits pulling a car out at the lunch hour and reparking. The three-hour limit may have been a concession to certain types of shop operators, since that seems about par for their normal business. But so far, it has been most satisfactory and only morning and afternoon police checks have been necessary.

This same time limit had to be imposed in portions of two parking fields near a railroad station. There, because of our licensing of station areas, spaces in our business fields were used by out-of-town commuters. The walking distance has now been increased to the point where we are having no difficulty.

The term "no attendants" refers only to personnel assigned to parking cars or regulating traffic. The department of public works has several employees regularly assigned to parking fields for cutting grass, litter work, and general cleanliness, supplemented by a park-division roving crew where there are extensive grass or landscaped areas. When traffic congestion is heavy during holiday periods, the regular police force is augmented by reserves.

There have been other interesting developments in the pattern. In one case, a parking field was designed particularly to handle a medical center, a block-front building, situated in the rear on land provided by the business owner. This land had been dedicated to the village, in lieu of a later assessment proceeding, before any commercial construction was started. It had an initial capacity of sixty-four cars. As the plan for the medical center and associated uses developed, it was obvious the parking capacity would be inadequate, and after negotiation, the owner acquired and deeded to the village an adjacent residence, adding a capacity of forty-one cars, which the village improved at general expense. Whether we purchase or condemn land, and assess the cost in either instance, the basic pattern remains the same. In some instances condemnation can be very expensive.

In this same parking lot, extraneous use developed from adjacent areas that the village could not well control, because the facility was improved by public funds. Complaints were justified; doctors, technicians, and patients, requiring only short-time parking, had great difficulty in getting near the building.

Extraneous Use of Lots Regulated

The answer has been experimental and temporary; this parking field has been leased to the owner of the building who is regulating access thereto. All-day legitimate parkers are segregated, and space is reserved at all times for in-and-out doctors and patients. A definite time-limit restriction in this particular parking field would not have been a solution. Results of the present plan show promise. In connection with this particular case, under zoning provisions previously cited, two applications have been made for additions to this building and both have been denied because of inadequate parking. If the owner offers additional property for parking, the application for a building permit may receive further consideration.

Another field having somewhat similar problems is being studied for corrective action. This field is on the perimeter of the village, tailor-made to serve six office buildings. On design basis, the car-space to floor-area ratio was above normally accepted standards, with an initial capacity of 326 cars. Yet several unusual problems developed. A village across the street on which our office buildings were situated, having inadequate parking facilities, installed meters and we acquired a large number of out-of-town guests. Our parking field was within a block of the county office center, and while there were adequate parking facilities, some were more remote from certain buildings in the group. As a matter of convenience, our field was used for all-day parking by a substantial number of county employees.

We also found car pools originating in this field—leaving two to four cars and taking one. This may not be a local phenomenon, but it certainly upsets unrestricted parking calculations. Four men, living in the same general area, all work in a plant twenty miles away. The four meet in a convenient (free) parking field, three cars are left and one goes on.

Some office buildings for which this field was designed were occupied by firms making more intensive use of floor area than would normally have been expected. The result was that the early-arriving employee found a parking space, but later-arriving executives did not. Clients and visitors to the offices did not, and the transient cars of staff personnel in several of the offices found their spaces pre-empted on return.

In our study of this problem, we have so far rejected the use of meters, as the original assessment for acquisition of the property was high. We considered leasing of the field to the several owners of the office buildings, but could not obtain unanimity of opinion. We are enacting an ordinance to restrict the use of about seventy-five percent of this parking field to accredited officers and employees of the office buildings by no-charge permits, evidenced by windshield stickers, and to place three-hour limitations on the remainder of the field for clients and visitors and in-and-out traffic. This field, with some reserve space, has recently been enlarged to maximum capacity of 380 cars, and screened by a high stockade fence and landscaping from adjacent residential property.

Parking Fields Fill Particular Needs

Questions have been asked as to how to determine "adequacy." These are difficult questions. The answer here will not be completely helpful. The challenging problem should receive most serious consideration by all traffic and planning agencies. Every car you can park off-street is one more out of the way. We have not found suitable formulas elsewhere, in zoning or other ordinances. Locally we find there can be no set rule. One office building, used professionally, may require only limited parking. Another of the same size may require five times the number of employees.

We consider each case individually. We calculate the parking requirements, taking into account the varying conditions.

Some of our parking fields abut directly on high-class residential property. In such cases, every effort has been made to avoid nuisance or depreciation factors, by reserving fifteen feet to twenty-five feet for heavy planting of evergreens and shrubs. In the older areas, this has proved adequate, but in newer fields, we have also used eight-

foot stockade cedar fencing supplemented by less intensive ornamental planting.

There are no privately operated public parking fields in the village, though there are private parking fields on private property, for the convenience of their employees and patrons. These are under permit, subject to review, and in every case meet requirements of design, capacity, construction, access, and screening. The co-operation of business property owners and merchants has been most helpful. Most persons are beginning to realize that the automobile and adequate parking are one of our greatest stocks in trade.

It is traditional that business establishments with rear access to municipal parking fields provide attractive rear entrances; show windows are used at such locations, and ornamental rear-yard planting has been accomplished. Many establishments provide enclosed refuse rooms on the parking field side. Stores provide "walk-through" areas from the parking field to the business street.

The city has continued its control of parking at the five railroad stations. Licenses are issued to *residents* for the nominal charge of two dollars a year. Some 500 spaces are available. This capacity is reasonably adequate under normal conditions. Station licensing has been supplemented by short-time parking on streets in the neighborhood, so that unauthorized out-of-town cars would not infringe on the residential streets. We have no meters, on streets or in parking fields. We have a high ratio of municipal free parking space to floor area, for retail stores and office buildings and apartments.

We have tried to design each parking field to its particular demand. Mass parking is not the answer in every community. Each traffic generator can pose a particular problem, which we have tried to anticipate in advance design or adjust by later regulation. The parking problem may never be solved to the satisfaction of all concerned, but with intelligent planning and the co-operation of all interests, average demands can be met with benefit to all.

Traffic and Rebuilding Cities

WILBUR S. SMITH

Mr. Smith is Technical Advisor of the Eno Foundation. He has been active in the field of traffic engineering since 1933. He is head of his own firm of consulting traffic engineers.

As America moves ahead on the transportation front, urban renewal emerges as a significant enterprise. Improvements in traffic and trade as well as preservation of the central business district are deeply involved. Urban renewal must be considered in its relation to the central business district and the city as a whole; inter-reactions are far-reaching.

Analysis can best begin with a study of the current position of the central business district, since urban renewal in most of its forms undertakes to renew sections of it.

For some years, central business districts have suffered from numerous types of decline—in number of persons, relative position in retail sales, land values, transit riders, number of businesses and relative additional capital investments. During this period, increased congestion and parking deficiencies have made trips downtown less pleasant and more expensive.

Concurrently, there has been an exodus of higher-income-bracket residents and businesses to suburban areas. Growth in population and new places of business have predominated in areas outside of the central business district and outside the central city of major metropolitan areas.

These threats to the health of the downtown district have come about in the form of blighted areas, relative reductions in tax income and a general lowering of its relative attractiveness as a place to work, shop, set up a new business, or expand an existing one. The city as a whole has suffered.

Shift in Retail Trade

There has been a general shift in retail trade away from the CBD and away from the central cities of metropolitan areas to suburban

sections. A study of the twenty-four largest metropolitan areas in the U.S. Bureau of Census Report on Retail Trade for 1954[1] showed that in 1948 the central business district accounted for 7.7 percent of all stores in the standard metropolitan areas, but by 1954 the figure had dropped to 7.4 percent. For the same years, the comparative volume of sales amounted to 20 percent of the twenty-four-area total but decreased to 15 percent.

In this same period, the sales volume of these downtown districts increased only one percent compared to 32 percent for all retailing, 21 percent for central cities, 32 percent for the twenty-four metropolitan areas, and 53 percent for the balance of the area.

An important factor in this is that people are moving out from centers.[2] From 1910 to 1950 the percentage of population classified as central city residents dropped from 77 to 58. Population increases in central cities were only 3.8 percent compared to 27.8 percent outside the central city. Not only are people moving out, but those moving have a higher disposable income.

A study in Chicago,[3] for example, showed that from 1948 to 1954 disposable income increased 12 percent, whereas in the Chicago metropolitan area—outside Chicago, but within Cook County—the increase was 50 percent and in the part of the metropolitan area outside of Cook County it was 72 percent.

Attractiveness Plus Improved Access

Faced with a less favorable competitive situation, cities have been trying to fight back to preserve, rejuvenate and strengthen the CBD. Efforts are being made to increase attractiveness, add more drawing power, and improve convenience. Urban renewal is aimed at greater attraction; added convenience is aimed at inducing more people to make the effort to travel to the attraction. A satisfactory result requires a balanced combination of both.

A tremendous gain in attractiveness cannot achieve much if con-

1. Census of Business: 1948 Central Business District Bulletins, Washington, D.C. Numbers 1, 2, 8, 12, 21, 27, 29, 31, 32, 33, 34, 37, 38, 40, 42, 43, 44, 45, 46, 48, 49 and 50.

2. Ames H. Hawley, "The Changing Scope of Metropolitan American Decentralization Since 1920." The Free Press, Glencoe, Illinois, 1956.

3. "Chicago's Metropolitan Growth: Patterns, Problems, Prospects." Business Executives Research Council of Greater Chicago.

gestion and parking difficulties remain. Substantial improvements in transportation cannot be expected if the desire to use it is not increased.

It is this dual requirement for success that makes the traffic aspects of urban renewal important. It must make as high a proportionate gain in convenience as it does in attractiveness.

An urban renewal project is in effect a total rebuilding of a central business district section. Looking ahead twenty-five to fifty years, a large enough series of urban renewal projects could rebuild most of an old CBD. Thus, the outlook must be rebuilding of a type that will not perpetuate the inadequacies of the old construction. To rebuild a section now, at no better level of traffic performance, would merely result ultimately in a rebuilt central business district essentially no better than the old one, and it would again suffer competitively as it has in the past.

Poor access and inadequate parking have brought the central business district to its present difficulties. The public might struggle through difficult traffic *once* to see a renewal project. But they are not likely to continue to come unless, after they have seen it, improvements in access and parking have been provided.

The transportation aspects of a renewal project must utilize the fullest capacity and highest rate of movement possible on fixed street-widths, with intersections controlled by signals. This, in turn, requires no stopping, standing, or parking at the curb. Unless the curb lane is used effectively for movement, the level of transportation cannot be raised significantly.

Off-street loading bays for commercial vehicles, off-street loading platforms for passengers, and off-street parking capacity must be comparable to the demand generated by new buildings. Only by this process can all street space be used exclusively for movement, to provide the essential capacity and rate of movement required for a central business district to compete successfully with businesses in less congested and concentrated areas.

The level of traffic performance on streets within a renewal project should considerably exceed that of the older streets which connect, until such time as stopping, standing and parking can be prohibited on these. Then, at least, the new section will have been pegged at a higher level and the objective set of ultimately bringing the other streets to this level.

If this concept is not thoroughly understood, and plans made accordingly, a renewal project can result in making the circulation and terminal efficiency of the entire central business district possibly less than it is now. If traffic generation is greater than the streets can accommodate, congestion within the project and on access routes will increase. If parking demand generated is greater than parking supply within the project, parking supply surrounding the project will be even more inadequate.

This situation would not only lower all circulation, and reduce the convenience of other buildings, but would limit business within the new project and prevent it from reaching its maximum design level. The increased congestion might well nullify the attractive features and create a preference for competing areas outside the CBD.

A city undertaking a renewal project in the central business district should give simultaneous consideration to traffic improvements throughout the central business district and the city as a whole. In fact, a renewal project running into many millions of dollars should serve as a stimulant to spearhead other traffic improvements.

Urban Renewal Streets Must Fit Planning

Traffic circulation plans of the internal roadway system of a renewal project must fit into the city's overall transportation plan. It should be adapted to projected expressways, surface arteries, one-way street networks, rapid transit routes and terminals—both bus and truck terminals. Intersection-spacing within the project must be designed for effective, flexible, progressive signal timing. In many communities a major handicap has been lack of transportation information and an overall master street plan as part of a general city plan. Hence, the unplanned development of a major renewal project may be incompatible with one based on, and fully considered in relation to, a prior overall plan.

In selecting the location and boundaries of an urban renewal project, attention should be given to present and planned expressways and surface arteries. It appears uneconomical to locate a project so that it straddles expressways and surface arteries designed to carry a high proportion of through-traffic. It would not be good

traffic planning to block future projected routes or to require later street widening, additional streets, elevated or depressed structures. Traffic arteries carrying largely through-traffic can usually be more effective at the edge of a renewal project than directly through it, although this is not always the case.

Traffic Generation of Project

Perhaps the first element of the renewal project picture is a study of traffic that will be generated by the businesses or structures to be built within the area. These include such items as:

Commuters; shoppers; number that will come by transit; number that will require parking; trucks required to deliver merchandise for sale; trucks required to deliver merchandise sold; volume of pedestrian traffic; peaks of arrival, accumulation and discharge; origin and destination of generated traffic.

This knowledge is essential to the design of roadway and terminal facilities, entrances and exits, and to estimate additional loads on access streets.

Commuters: If the project is to contain a substantial amount of office space, it will generate a considerable volume of commuters. This volume should be computed accurately because it can have a marked effect on traffic loads. If several thousand persons are added to the 7:00 to 9:00 morning peak and the 5:00 to 6:00 afternoon peak, the overload creates serious consequences.

Shoppers: If the project is preponderantly a retail shopping area it will generate large numbers of shoppers. These should be estimated carefully, since shopping peaks differ from commuting peaks. A renewal project containing many stores creates in effect a downtown shopping center. To compete successfully in this category will require special attention to customer parking.

Transit: Knowing that fixed street-widths have a traffic-capacity ceiling and that a renewal project is certain to add appreciably to the load on the street system, planners must give careful attention to transit. Forecasts should be made of the percentage of shoppers and commuters who will choose to come by transit. Special arrangements must be made to make transit attractive.

Transit is not a substitute for private cars any more than cars

are a substitute for transit. Both are essential elements of a balanced transportation system. Once new generation of traffic by renewal projects reaches the street system's vehicle-capacity, the only practical way to get more people downtown is to encourage transit use.

Arrival, Accumulation and Discharge Peaks: The critical part of estimating traffic generation of a renewal project is the estimation of peak volumes. It is during the peaks that the street system is under its heaviest load and the greatest congestion prevails.

A hydraulic comparison makes this easier to understand. If each street is considered as a pipe line, and an attempt is made to force an excessive volume through it, the substance will merely back up to points farther out on the system. Traffic generation must be balanced with traffic capacity.

Origin and Destination of Generated Traffic: Not only do total volume and peak of new traffic generated by the project have to be estimated, but its origins must be determined. If origin-and-destination studies show that a higher proportion of generated traffic can be expected to come from one direction, a special analysis of existing routes in that direction must be made to determine whether their capacity will permit the additional load and to what degree of congestion.

Truck Volume: If the nature of the business in the renewal project is largely truck delivery and pick-up, a study should be made of off-street loading bays. Their requisite number and suitable location can do much to prevent further increases in congestion. If the volume is sufficient, it may be necessary to provide special truck service drives that will keep trucks entirely out of the regular traffic stream.

Pedestrian Traffic: The volume, origin and destination of pedestrians in the renewal project should be plotted. Adequate sidewalks and walkways will be required to keep conflicts with vehicular traffic to a minimum. Tunnel and bridge connections between buildings should be considered. Controlled pedestrian crossing at signalized intersections is essential.

Internal Traffic Arrangements

The internal off-street traffic arrangements based on generation figures would include the following:

1. Entrances and exits on streets surrounding the project area and passing through it.
2. Reservoir space.
3. Separate entrances, exits and service drives for commercial vehicles.
4. Left turn controls.
5. Off-street loading stations for transit riders.
6. Internal transit routes.
7. Unloading platforms at major buildings for private car passengers.
8. Traffic signals, signs and markings.
9. Roadways to and from parking lots and garages.
10. Channelization.
11. Walkways between buildings and parking facilities.
12. Street and sidewalk lighting.
13. Truck unloading platforms within buildings.
14. Storage and routing of maintenance vehicles.
15. Parking lots, garages and service facilities.

Entrances and exits on surrounding and penetrating streets must be sufficient in number, of such capacity and so located that, during the inbound and outbound peaks, traffic entering and leaving will not back up and overload the streets.

Streets that run through the renewal project and are continuations of streets on each side should be designed to have higher capacities and rates of movement than their extensions or counterparts outside of the project. Design characteristics should include:

Wider Lanes: In considering an urban renewal area, as in laying out a new city, one would automatically think of streets with lanes of ample width rather than of old streets frequently no more than eight or nine feet wide. Depending upon the rate of movement and the proportion of large trucks anticipated, the new lanes should range between eleven and twelve feet. If parking lanes are contemplated—though this is questionable when ample off-street space is provided—they should be a minimum of eight or nine feet.

The National Committee on Urban Transportation[4] presents a summary of minimum design standards for urban streets:

4. "Better Transportation for Your City," p. 50.

Design Elements (all widths in feet)	*Expressway*	COLLECTOR STREET *Major arterial*	COLLECTOR STREET *Single family residential area*	COLLECTOR STREET *Other*	LOCAL STREET *Single family residential area*	LOCAL STREET *Other*
Number of traffic lanes	4 up	4–6	2	4	2	2–4
Width of traffic lanes	12	11	10	11	10	11
Width of Curb Parking Lane or shoulder	10	10	10	10	8*	10
Width of border area	16	12	10	8	10	8
Median width	20	12	—	—	—	—
Width of right-of-way	120 up	100–200	60	80	50–60	60–80

*Under light traffic conditions, parking may be limited to one side.

Number of Lanes Mid-block: This must be approached from the point of view of matching internal streets with long-range future capacities of connecting streets. If these can be converted to moving lanes (by prohibiting stopping, standing or parking), then these should be equalled. In no case would it seem advisable to provide fewer than the number of maximum moving lanes on external streets.

Where space permits, the advantages of a divided roadway should be included. In cases where mid-block left turns on very long internal streets are planned, channelization and shadowing should be used to store cars waiting for left turns, especially where weaving or merging will be required.

Number of Lanes at Intersections: It is suggested that the new design should provide lanes for critical left turns, right turns and as many for straight-through as necessary. This precaution will allow for greater flexibility in signal control.

Entrances and Exits to Off-street Areas: These should be planned to provide minimum disturbance to the flow of traffic on adjacent as well as interior streets. Access points must be sufficient in number to distribute the load and have sufficient capacity to provide storage space for waiting cars.

Other Design Features: Many other design items such as gradual curb returns, pull-out bus loading platforms, channelization, modern street lighting, and landscaped fencing to control pedestrian movements should be given particular consideration.

Access to Renewal Projects

The problem of assuring that the desired amount of traffic can get to and from a renewal area at a satisfactory rate of movement can be a complex one. The original selection of the project's location is important and bears heavily on a satisfactory solution. If it is located where it can be readily served by existing expressways or surface arteries, or through short connections, it is fortunate.

In many instances an urban renewal project takes place in an area where business activity and property values have declined and where the area generates little traffic, thus placing negligible direct traffic loads on the adjacent streets and arteries leading to it. When this situation is replaced by a renewal project that will generate a substantial amount of traffic, the increased load placed upon adjacent streets and access arteries must be computed carefully. Otherwise, the resulting traffic overload will create serious congestion.

In downtown areas of many cities, only one lane in each direction is available for movement because curb space is taken up by parking. The parking and unparking process further reduces capacity and rate of movement on available lanes. It is obvious that if a renewal area is surrounded by such one-lane streets barely able to serve existing traffic, a substantial increase due to the renewal project will only add to congestion.

If the decision is to proceed with the project in these circumstances, then specific traffic engineering steps must be taken to convert the one-lane streets to two-lane. This change will involve the progressive sequence of prohibiting parking back from the corners to gain a turning lane; prohibiting parking on the inbound side during the morning rush; on the outbound side during the afternoon peak; both sides during both peaks, and finally all day. This conversion may be accompanied by "no-stopping" regulations and "tow away" zones when traffic pressure becomes critical.

If parking prohibitions are enforced, the curb lane may still not

prove efficient if truck loading and unloading are frequent. The prohibition of truck loading during certain hours may prove advisable but difficult to accomplish.

If parking prohibition, coupled with an off-street parking program, cannot be satisfactorily accomplished, then it is advisable to seriously consider one-way streets—if the street plan will permit use of balanced pairs. Thus, to obtain suitable access to a renewal project, it is obvious that other traffic improvement plans become imperative and must be considered simultaneously.

In extreme cases, it may be found that existing adjacent streets, where narrow, cannot carry the projected additional load that will be generated by the renewal project. It may be necessary to force cutting through some dead-end streets, widening others, or creating additional ones. These measures involve substantial expenditures. As difficult as the traffic requirements of an urban renewal project may sound, there is no escape. The demand for more traffic movement must be met by an increased supply of capacity.

The National Committee on Urban Transportation[5] recommends the following operational speed ability: Expressways 35–50 (at least 35 at peaks), major arterials 25–35 (at least 35 at peaks), collector streets 20–25, local streets 10–20.

The following table shows minimum desirable auto travel time for trips of various lengths.

AVERAGE WEEKDAY PEAK HOUR

Length of Trip	*Travel Time*
2 miles	7 minutes
4 miles	12 minutes
6 miles	16 minutes
8 miles	20 minutes
10 miles	24 minutes
12 miles	28 minutes

The important point to keep in mind is that these levels of movement should prevail after being subjected to the additional load of traffic generated by the renewal project.

5. Ibid. pp. 45 and 50.

In renewing a section of the central business district, parking facilities to be included should obviously be superior to older sections where, in most cases, the opportunity has not been nearly as good, and where ease of parking has suffered badly by comparison with shopping centers outside the area.

The value of parking to a central business district is clearly shown by an interview of 15,000 separate householders of all income brackets and social status in a midwestern city. When asked why they did not like downtown, the reason given in the highest percentage of answers was "difficult parking." It ranged from 33 percent for the lowest income group to 51.3 percent for the highest income group.[6]

Parking Facilities for Renewal Projects

Central business districts have relatively less off-street parking in relation to retail store space than shopping centers. The common measure is the P.I.—parking index—the ratio of the number of parking spaces per 1,000 gross square feet of retail generating area. Few cities have an index of one. Cities sometimes require developers to provide from two to four times as much parking space as floor space.

Modern shopping centers are designed with a parking index of five to eight, or many times that found downtown. It is small wonder that every year more and more motorists show a preference for shopping in centers outside of downtown. Not only does the central business district suffer in volume of space but a fee must be charged, whereas parking lots in shopping centers are free. These facts point up the urgency of improving central business district parking.

City officials have long recognized the need of making parking improvements. To prevent off-street parking from becoming worse, zoning ordinances require that when new buildings are erected they must be provided with their own off-street parking facilities. The following are some examples[7]:

Restaurants, one space per 400 to 1,000 square feet, or per three to 20 seats; auditorium, one space per three to 20 seats; office buildings, one space per 3,000 square feet minimum to one space per

6. "Transportation and Parking Facilities in Downtown Rehabilitation," Traffic Quarterly, October 1957, Frank Emery Cox.

7. *Parking*, 1957, p. 231. Robert H. Burrage and Edward G. Mogren. Eno Foundation, Saugatuck, Connecticut.

150 square feet maximum. In such ordinances a car space is taken as 200 square feet and the facilities must be within 200 to 500 feet of the new building.

A growing tendency in shopping center design—and this should be considered in designing parking lots—is to use 90-degree parking with two-way aisles, and stall widths of nine feet rather than eight and a half, especially if a large percent of parkers are women shoppers carrying shopping bags and packages. These dimensions require less time to park and unpark, and aisles are blocked a shorter time. Turn-back arrangements should be made so that drivers in search of a space may move from one parking bay to another. Parking aisles will be easily used as pedestrian walkways. Special pedestrian walkways will not be used frequently unless they lead directly toward buildings.

Professional opinion suggests that the median distance from parking spaces to buildings should be about 120 feet and the great majority should be within 300 feet. Parking spaces should be designated by conspicuous signs. Individual stalls should be delineated by pavement markings.

Since adequate parking facilities for a renewal area will require a substantial capital investment and usually must be made self-liquidating through parking revenue, it is important that experts make an economic feasibility study.

Unfortunately, in too many cities urban renewal projects arrive on the scene prematurely from the point of view of other essential developments. If a community has no full-time technically trained staff, the handicap is serious. Many have not taken the step of employing necessary engineering and planning consultants to provide themselves at least with a master plan of operations based on technical surveys.

Without a basic plan, the location of the project must be made largely on conjecture. In the absence of a master plan, future access-arteries, one-way streets, an efficient traffic circulation plan, and suitable facilities for parking may require extensive revisions and higher costs.

In many instances, a renewal project is similar to a shopping center. To promote it successfully requires a combination of expert talents. Obviously an urban renewal project requires the expenditure of large funds and warrants a team of qualified experts from

various fields to assure that it does not hinder other later proposed improvements while making a fundamental long-range improvement to the central business district status.

At this stage of important transportation developments in our country, cities are in a difficult position. The multi-million dollar highway program accelerated annual transportation improvements at the state level at a rate of two, three and four times that achieved each year in the previous fifteen years.

It is true that some of the billions filter down to the city level, as in the 6,000 of the 42,000 miles of the interstate system, to be built within urban areas. But in every large city such expressways represent only part of the essential road net that will ultimately be required. Nor does the interstate federal money make any contribution to collection and distribution systems of surface arteries and improved movement on streets. These must be provided to match federal and state improvements. Strictly from the viewpoint of relative values, cities are presently in a poor position to finance or provide the technical services for transportation gains equivalent to those at the state level. Yet this problem must be solved if we are to have a balanced transportation program.

Modern buildings and roadways are designed with a minimum life expectancy of thirty years. They must therefore be planned to provide for estimated increases in traffic and trade. Estimates of future population, drivers, vehicles and miles of travel are great and difficult to visualize. By 1975 they amount to 227 million,[8] 118 million and one trillion miles of travel respectively.

In a life span and with these figures, it is difficult to estimate how much of this growth can be attracted downtown as a benefit to the central business district. It will require long-term well-planned efforts to make the CBD increasingly attractive and easier to approach. If this is not done, the obvious trends of people and purchasing power to move farther out may continue.

Urban renewal, offering an opportunity to improve attractiveness, movement and parking within its area, and serving as a stimulus to make substantial gains in access to the central business district, holds great promise if all phases are given high priority.

8. "Where Will United States Put 60 Million More People?" U.S. News and World Report, August 9, 1957.